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(12) **United States Patent**
Yoo

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(45) **Date of Patent: Dec. 29, 2015**

(54) **ANTI-MALWARE SYSTEM AND OPERATING METHOD THEREOF**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 629 days.

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May 30, 2011 (KR) 10-2011-0051706

(51) **Int. Cl.**
G06F 11/00 (2006.01)
G06F 21/55 (2013.01)
G06F 21/56 (2013.01)
H04L 29/06 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 21/554*** (2013.01); ***G06F 21/564*** (2013.01); ***H04L 63/145*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 21/554; G06F 21/564; H04L 63/145
See application file for complete search history.

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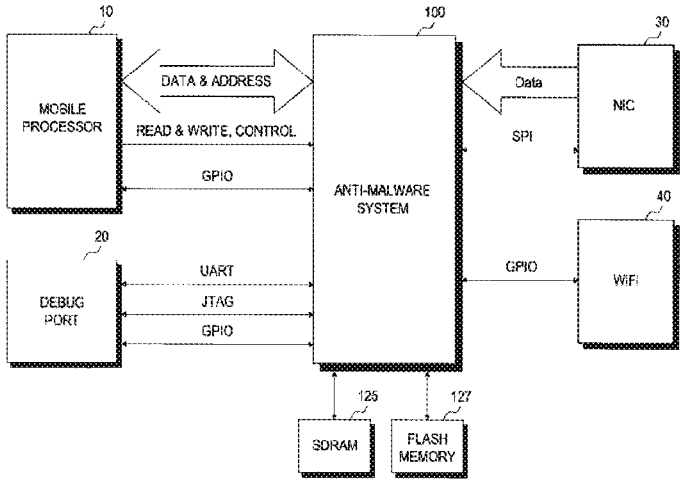
(Continued)

Primary Examiner — Brandon Hoffman
Assistant Examiner — Nega Woldemariam
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

Provided are an anti-malware system, and an operating method thereof. The anti-malware system matches an filtering operation on first target data to be filtered with a rule pattern, performs a filtering operation on the first target data according to a matching result, matches second target data to be malware-scanned with a malware pattern, and performs a malware scanning operation on the second target data according to a matching result, wherein the filtering operation and the scanning operation are performed on a system-on-chip (SoC).

44 Claims, 30 Drawing Sheets
(6 of 30 Drawing Sheet(s) Filed in Color)



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Lockwood, J. W. et., al. "An Extensible, System-On-Programmable-Chip, Content-Aware Internet Firewall", Jan. 1, 2003, 10 pages total.
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Communication, dated Jan. 30, 2012, issued by the European Patent Office in corresponding European Application No. 11168862.8.
Office Action issued by the Korean Patent Office dated May 19, 2011 in a counterpart application No. 10-2010-0057824.
Communication, dated Jul. 9, 2013, issued by the Japanese Patent Office in counterpart Japanese Patent Application No. 2011-127380.

* cited by examiner

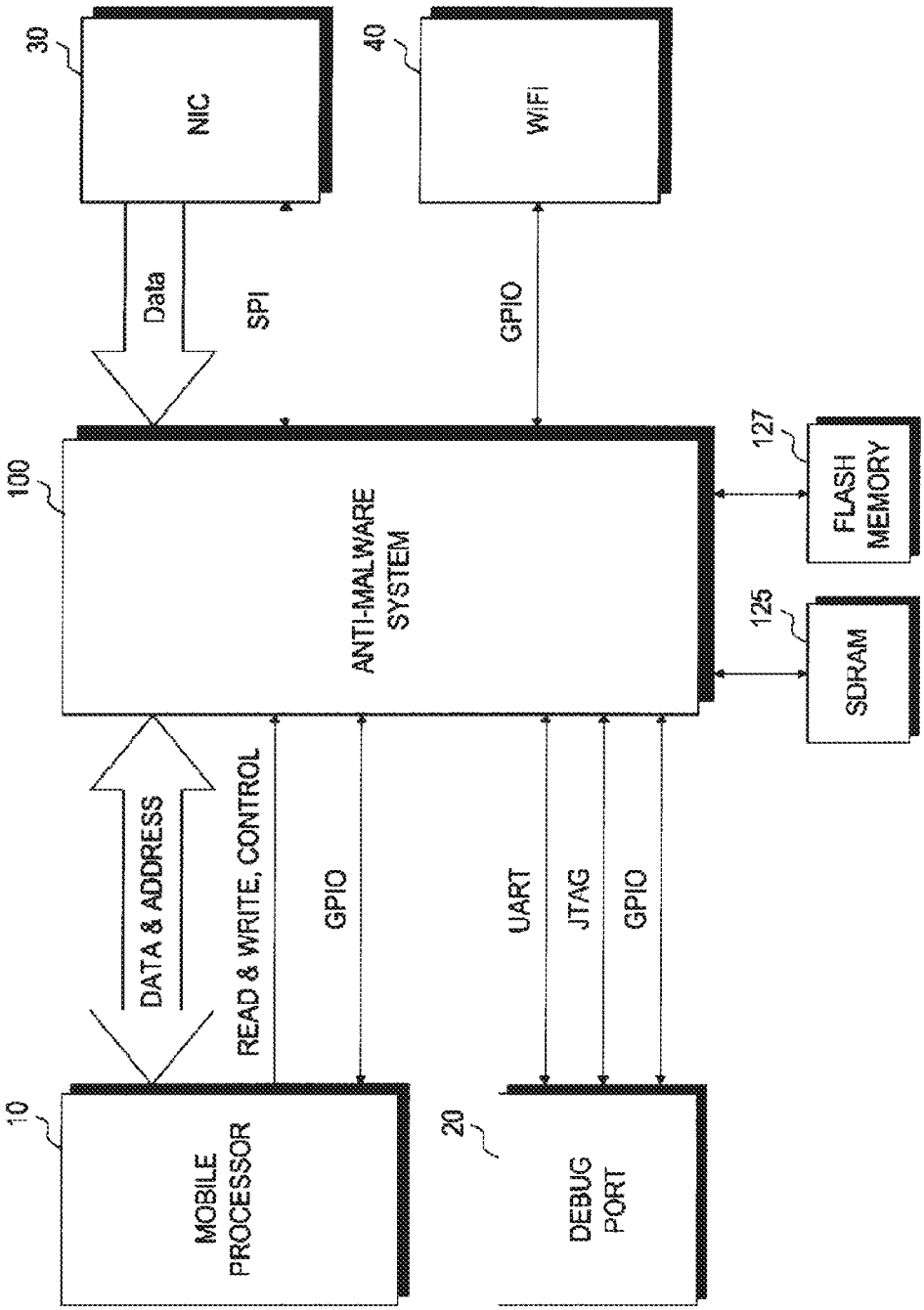

30
NIC
40
WiFi
Data
SPI
GPIO
100
ANTI-MALWARE SYSTEM
127
FLASH MEMORY
125
SDRAM
DATA & ADDRESS
READ & WRITE, CONTROL
GPIO
UART
JTAG
GPIO
10
MOBILE PROCESSOR
20
DEBUG PORT

FIG. 1

FIG. 2

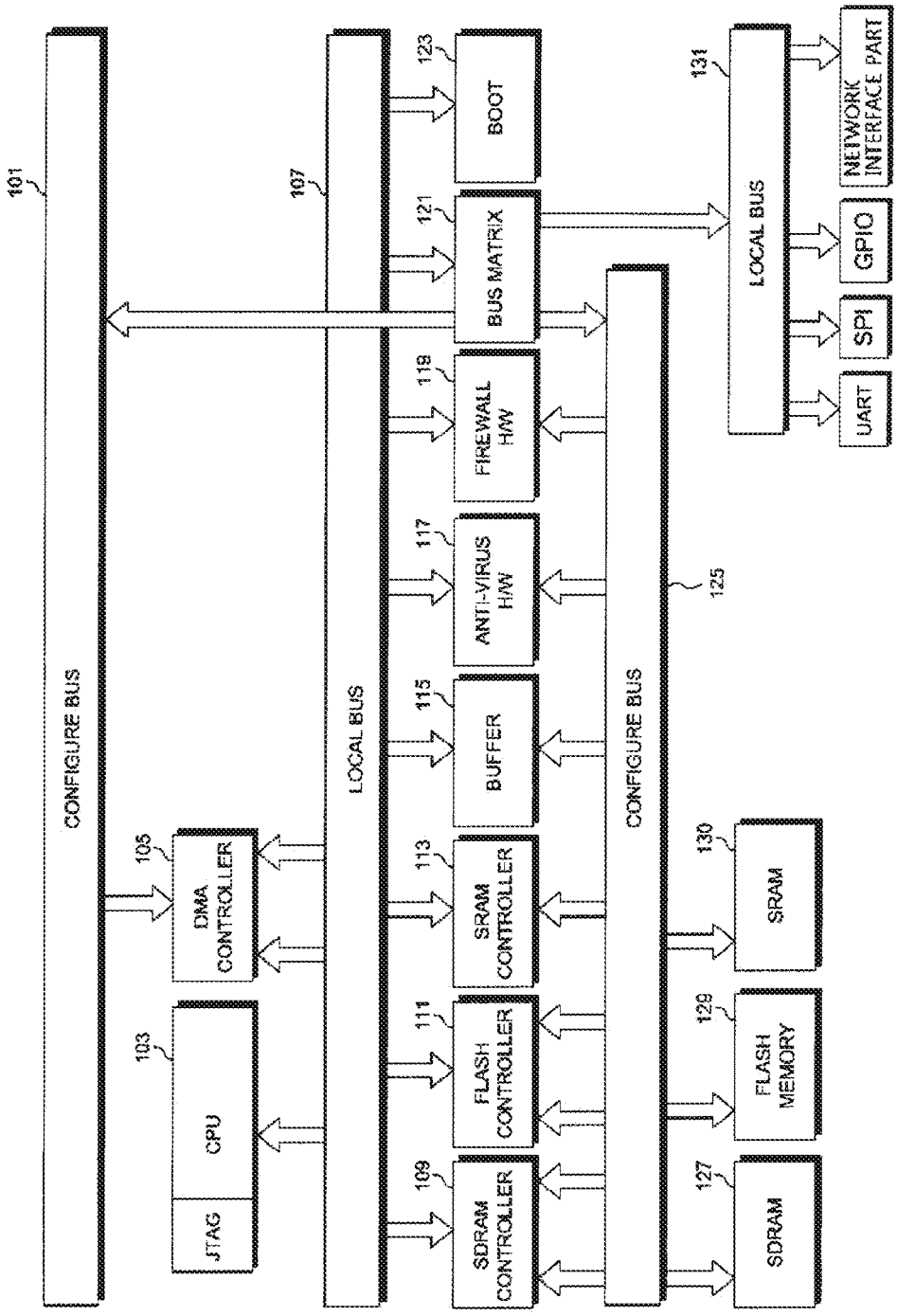

CONFIGURE BUS
101
LOCAL BUS
107
CONFIGURE BUS
125
LOCAL BUS
131
CPU
JTAG
103
DMA CONTROLLER
105
BOOT
123
BUS MATRIX
121
FIREWALL H/W
119
ANTI-VIRUS H/W
117
BUFFER
115
SRAM CONTROLLER
113
FLASH CONTROLLER
111
SDRAM CONTROLLER
109
SRAM
130
FLASH MEMORY
129
SDRAM
127
NETWORK INTERFACE PART
GPIO
SPI
UART

FIG. 3

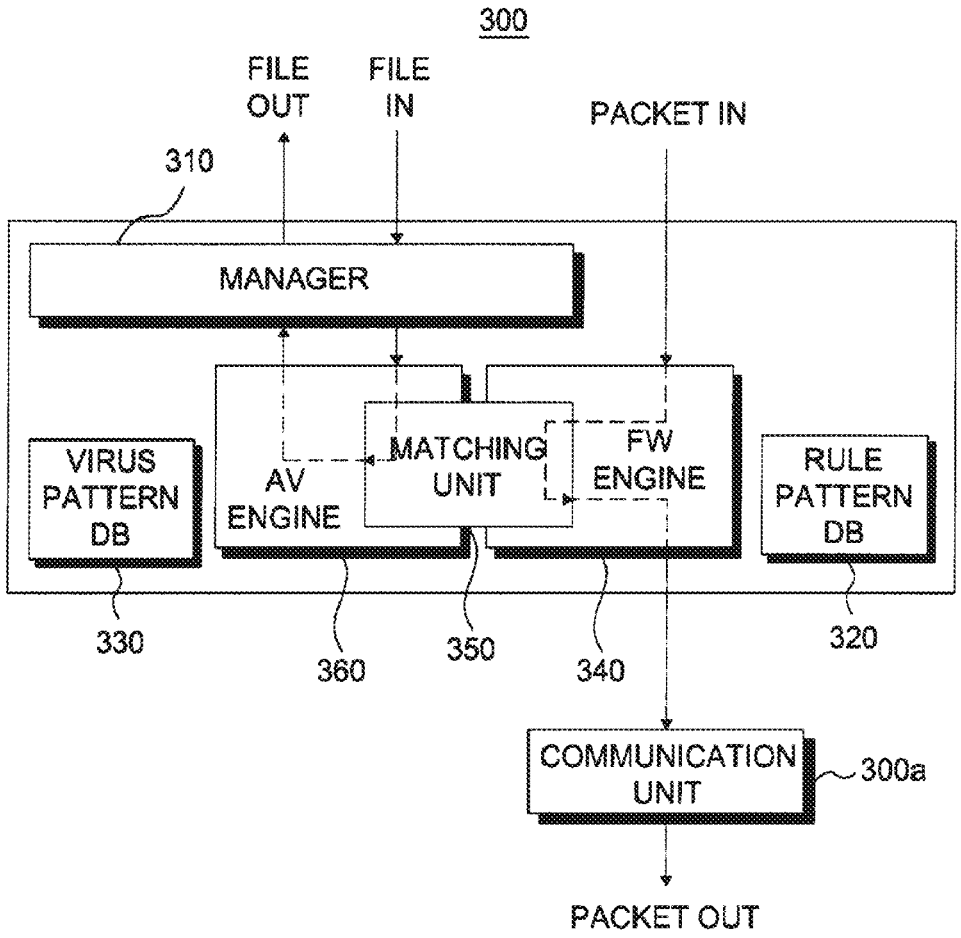

300
FILE OUT
FILE IN
PACKET IN
310
MANAGER
VIRUS PATTERN DB
AV ENGINE
MATCHING UNIT
FW ENGINE
RULE PATTERN DB
330
360
350
340
320
COMMUNICATION UNIT
300a
PACKET OUT

Fig. 4

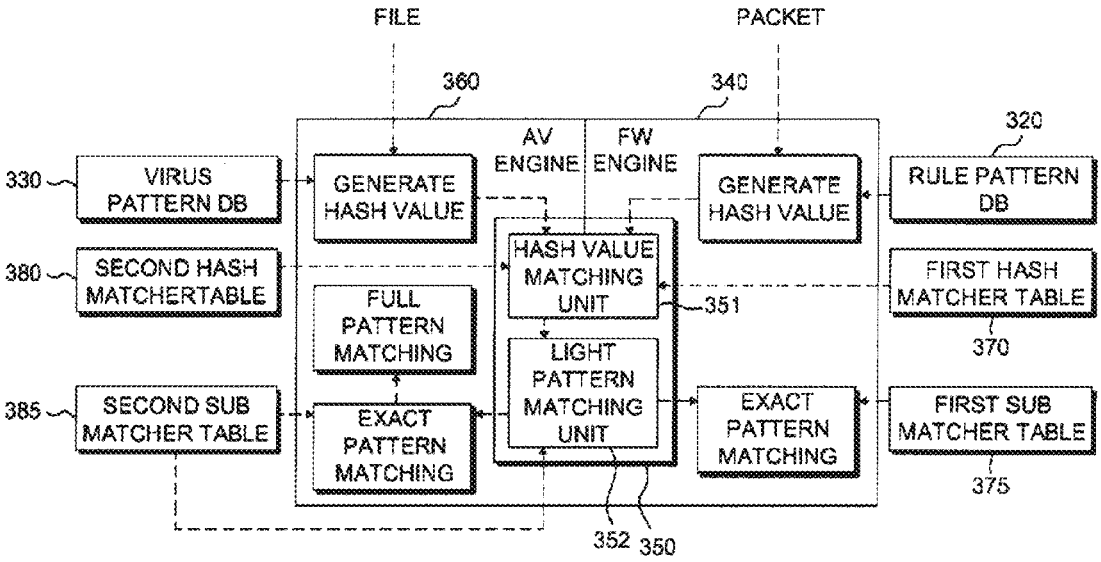

FILE
PACKET
360
340
320
AV ENGINE
FW ENGINE
330
VIRUS PATTERN DB
GENERATE HASH VALUE
GENERATE HASH VALUE
RULE PATTERN DB
380
SECOND HASH MATCHERTABLE
HASH VALUE MATCHING UNIT
FIRST HASH MATCHER TABLE
351
370
FULL PATTERN MATCHING
LIGHT PATTERN MATCHING UNIT
385
SECOND SUB MATCHER TABLE
EXACT PATTERN MATCHING
EXACT PATTERN MATCHING
FIRST SUB MATCHER TABLE
375
352
350

FIG. 5

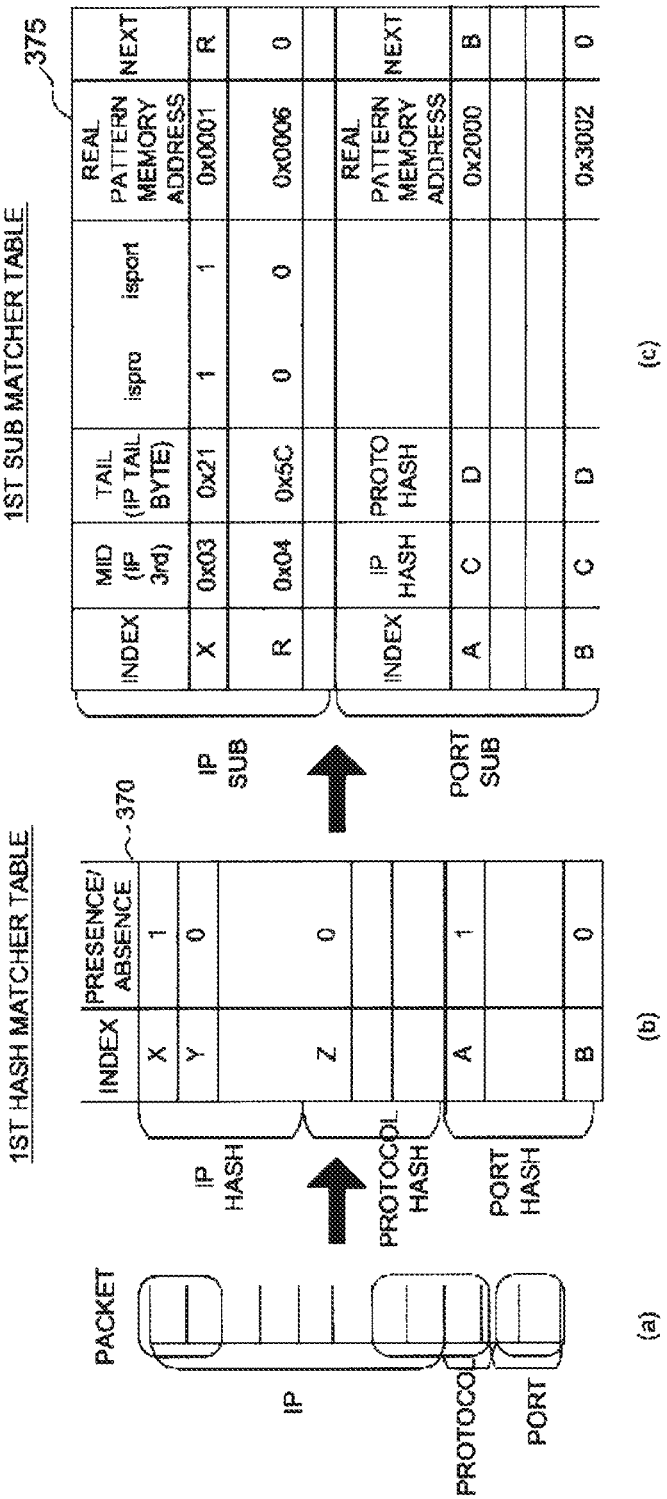
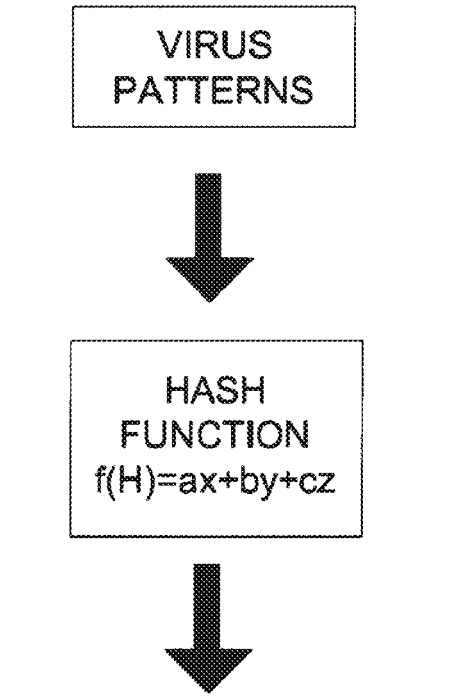

PACKET
IP
PROTOCOL
PORT
(a)
1ST HASH MATCHER TABLE
370
INDEX
PRESENCE/ ABSENCE
X
1
Y
0
Z
0
A
1
B
0
IP HASH
PROTOCOL HASH
PORT HASH
(b)
IP SUB
PORT SUB
1ST SUB MATCHER TABLE
375
INDEX
MID (IP 3rd)
TAIL (IP TAIL BYTE)
ispro
isport
REAL PATTERN MEMORY ADDRESS
NEXT
X
0x03
0x21
1
1
0x0001
R
R
0x04
0x5C
0
0
0x0006
0
INDEX
IP HASH
PROTO HASH
REAL PATTERN MEMORY ADDRESS
NEXT
A
C
D
0x2000
B
B
C
D
0x3002
0
(c)

FIG. 6



PATTERN HASH TABLE	
HASH VALUE (HP)	PATTERN
X	abcdefg
Y	hiiklmnopq
X	abcxyz
...	...

FIG. 7

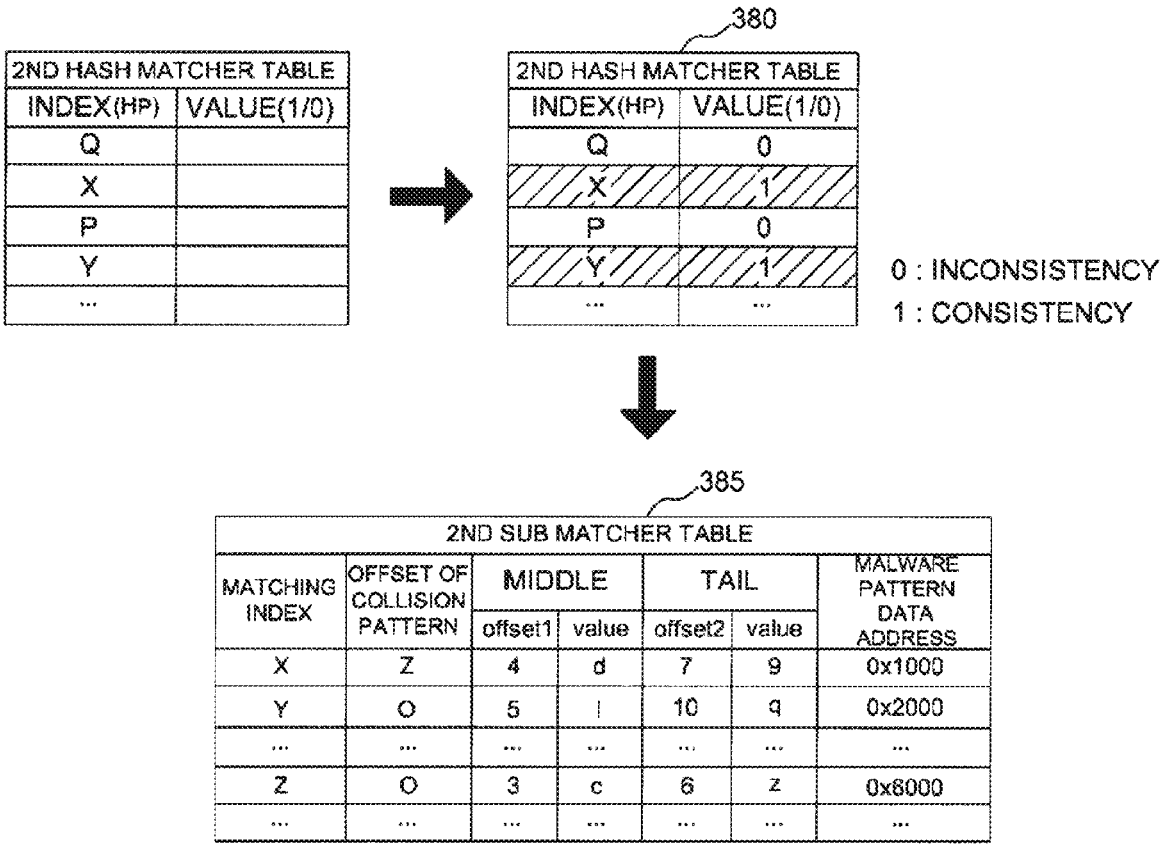

2ND HASH MATCHER TABLE
INDEX(HP)
VALUE(1/0)
Q
X
P
Y
...
380
2ND HASH MATCHER TABLE
INDEX(HP)
VALUE(1/0)
Q
0
X
1
P
0
Y
1
...
...
0 : INCONSISTENCY
1 : CONSISTENCY
385
2ND SUB MATCHER TABLE
MATCHING INDEX
OFFSET OF COLLISION PATTERN
MIDDLE
TAIL
MALWARE PATTERN DATA ADDRESS
offset1
value
offset2
value
X
Z
4
d
7
9
0x1000
Y
O
5
l
10
q
0x2000
...
...
...
...
...
...
...
Z
O
3
c
6
z
0x6000
...
...
...
...
...
...
...

FIG. 8

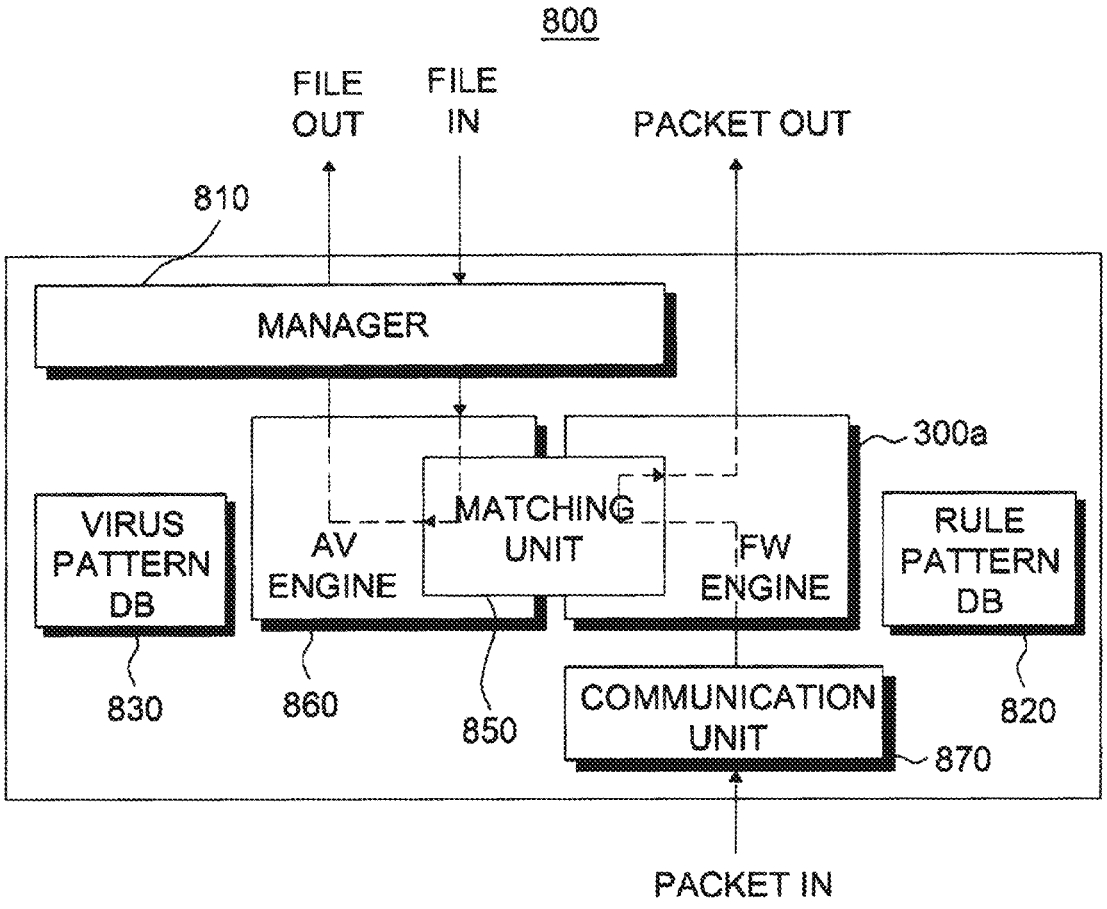

800
FILE OUT
FILE IN
PACKET OUT
810
MANAGER
300a
VIRUS PATTERN DB
AV ENGINE
MATCHING UNIT
FW ENGINE
RULE PATTERN DB
830
860
850
COMMUNICATION UNIT
820
870
PACKET IN

FIG. 9

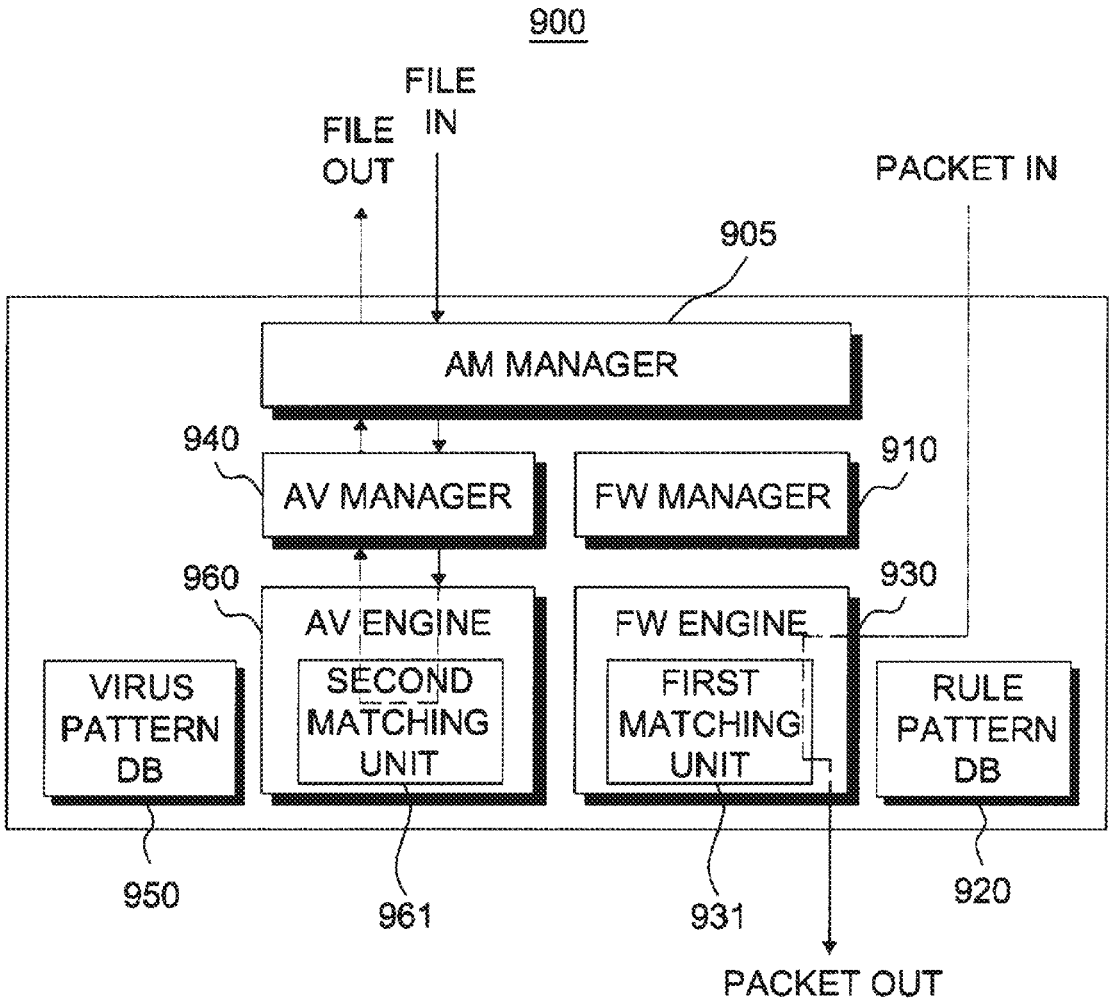

900
FILE IN
FILE OUT
PACKET IN
905
AM MANAGER
940
AV MANAGER
FW MANAGER
910
960
AV ENGINE
FW ENGINE
930
VIRUS PATTERN DB
SECOND MATCHING UNIT
FIRST MATCHING UNIT
RULE PATTERN DB
950
961
931
920
PACKET OUT

FIG. 10

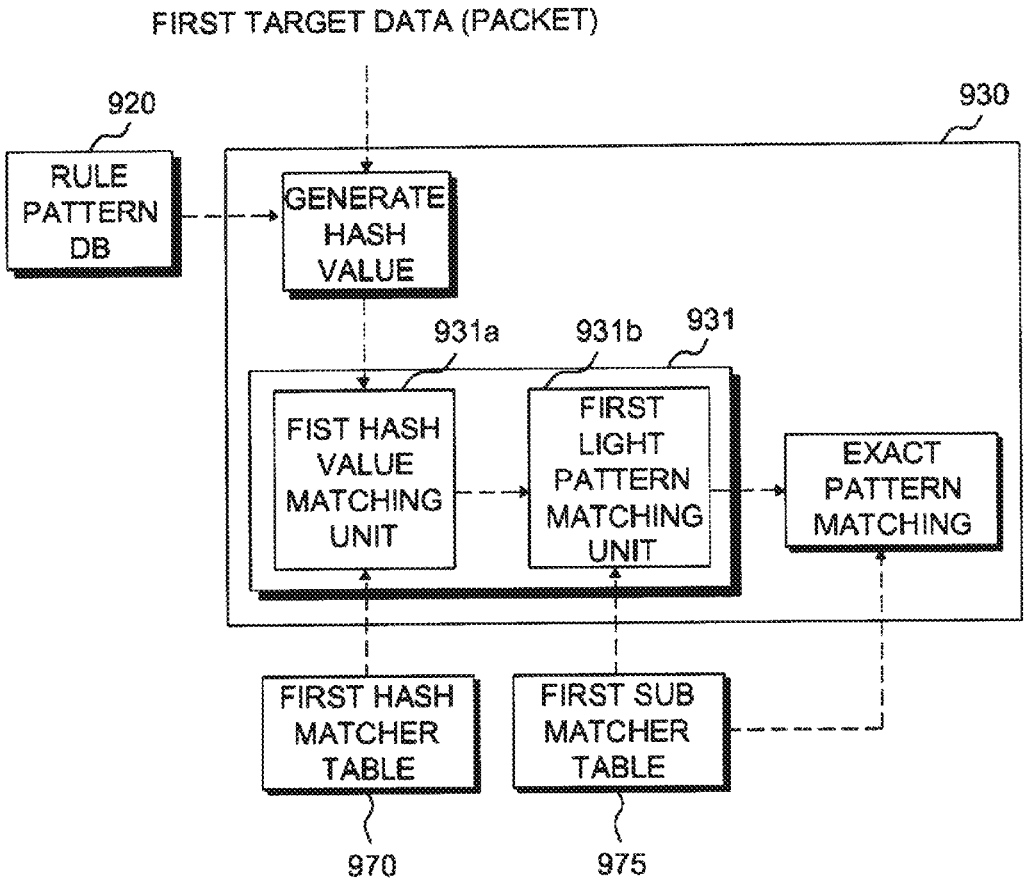

FIRST TARGET DATA (PACKET)
920
930
RULE PATTERN DB
GENERATE HASH VALUE
931a
931b
931
FIST HASH VALUE MATCHING UNIT
FIRST LIGHT PATTERN MATCHING UNIT
EXACT PATTERN MATCHING
FIRST HASH MATCHER TABLE
FIRST SUB MATCHER TABLE
970
975

FIG. 11

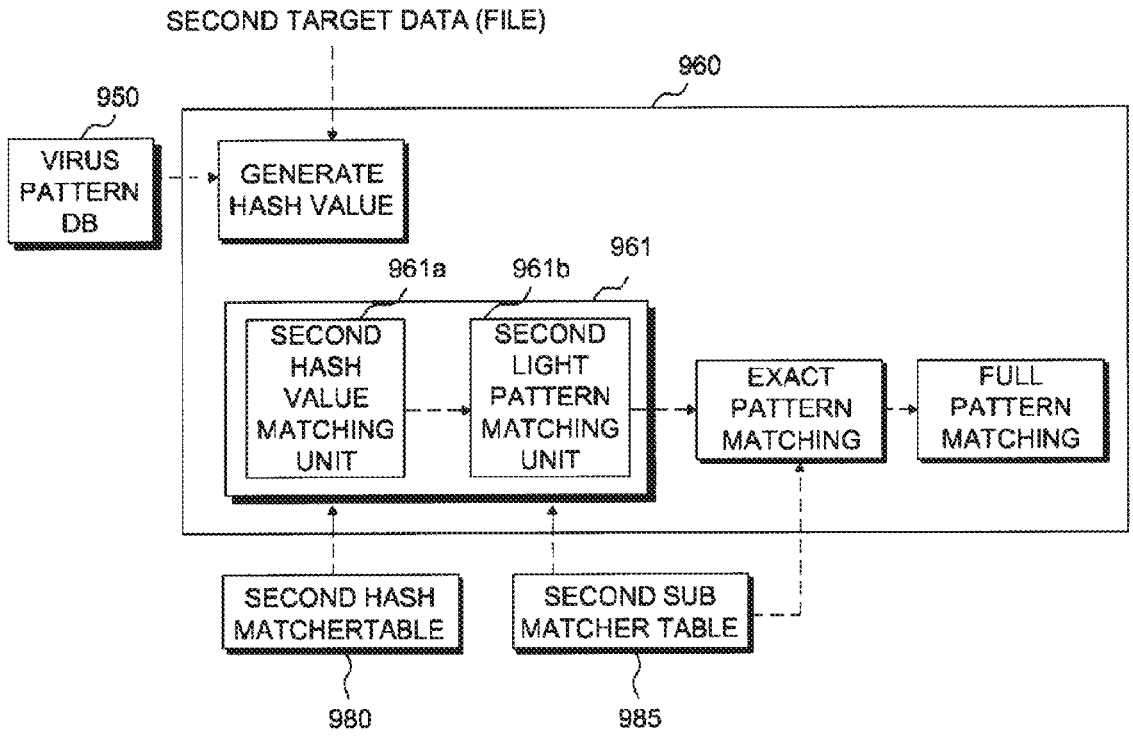

SECOND TARGET DATA (FILE)
960
950
VIRUS PATTERN DB
GENERATE HASH VALUE
961
961a
961b
SECOND HASH VALUE MATCHING UNIT
SECOND LIGHT PATTERN MATCHING UNIT
EXACT PATTERN MATCHING
FULL PATTERN MATCHING
SECOND HASH MATCHERTABLE
SECOND SUB MATCHER TABLE
980
985

FIG. 12

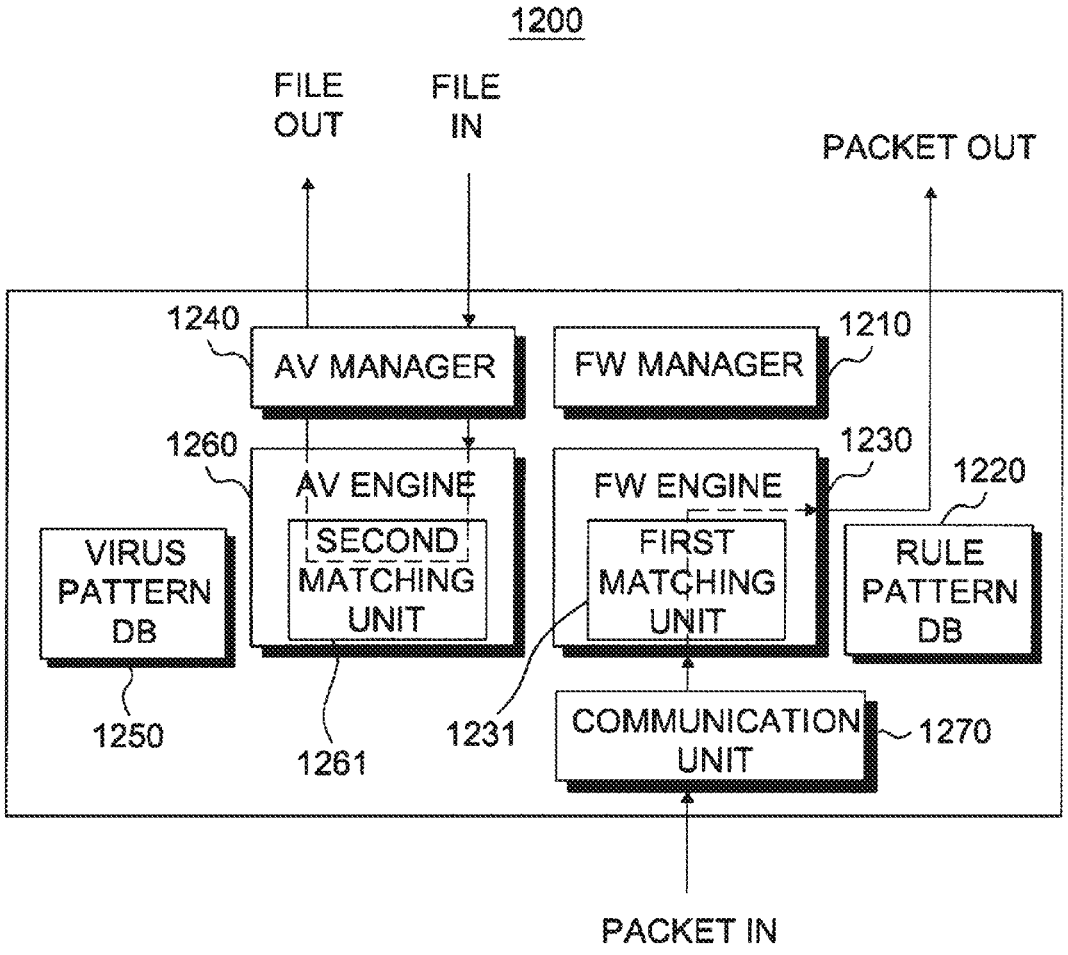
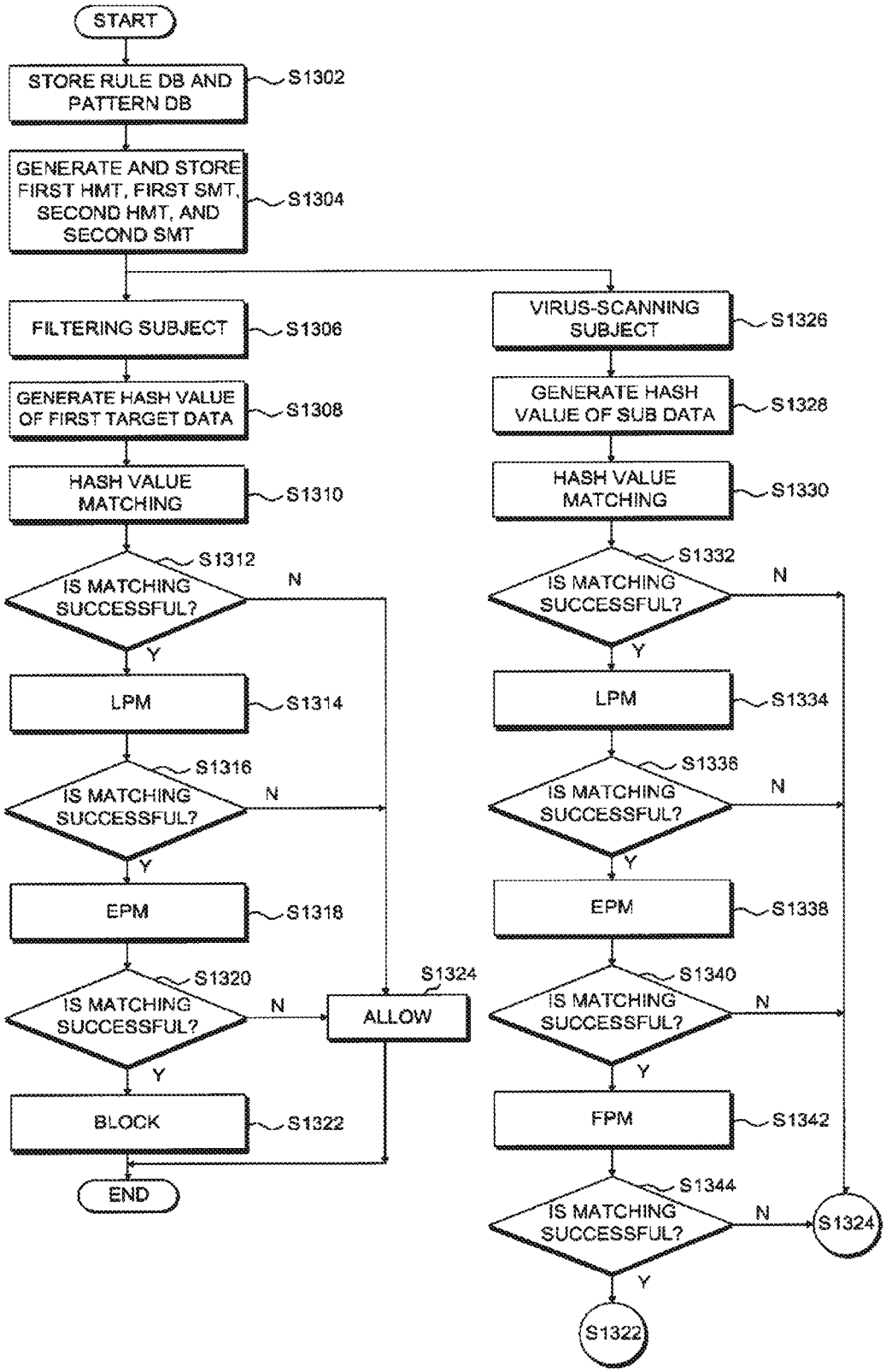

1200
FILE OUT
FILE IN
PACKET OUT
1240
AV MANAGER
FW MANAGER
1210
1260
AV ENGINE
FW ENGINE
1230
1220
VIRUS PATTERN DB
SECOND MATCHING UNIT
FIRST MATCHING UNIT
RULE PATTERN DB
1250
1261
1231
COMMUNICATION UNIT
1270
PACKET IN

FIG. 13


START
STORE RULE DB AND PATTERN DB
S1302
GENERATE AND STORE FIRST HMT, FIRST SMT, SECOND HMT, AND SECOND SMT
S1304
FILTERING SUBJECT
S1306
GENERATE HASH VALUE OF FIRST TARGET DATA
S1308
HASH VALUE MATCHING
S1310
S1312
IS MATCHING SUCCESSFUL?
N
Y
LPM
S1314
S1316
IS MATCHING SUCCESSFUL?
N
Y
EPM
S1318
S1320
IS MATCHING SUCCESSFUL?
N
Y
BLOCK
S1322
END
S1324
ALLOW
VIRUS-SCANNING SUBJECT
S1326
GENERATE HASH VALUE OF SUB DATA
S1328
HASH VALUE MATCHING
S1330
S1332
IS MATCHING SUCCESSFUL?
N
Y
LPM
S1334
S1336
IS MATCHING SUCCESSFUL?
N
Y
EPM
S1338
S1340
IS MATCHING SUCCESSFUL?
N
Y
FPM
S1342
S1344
IS MATCHING SUCCESSFUL?
N
Y
S1324
S1322

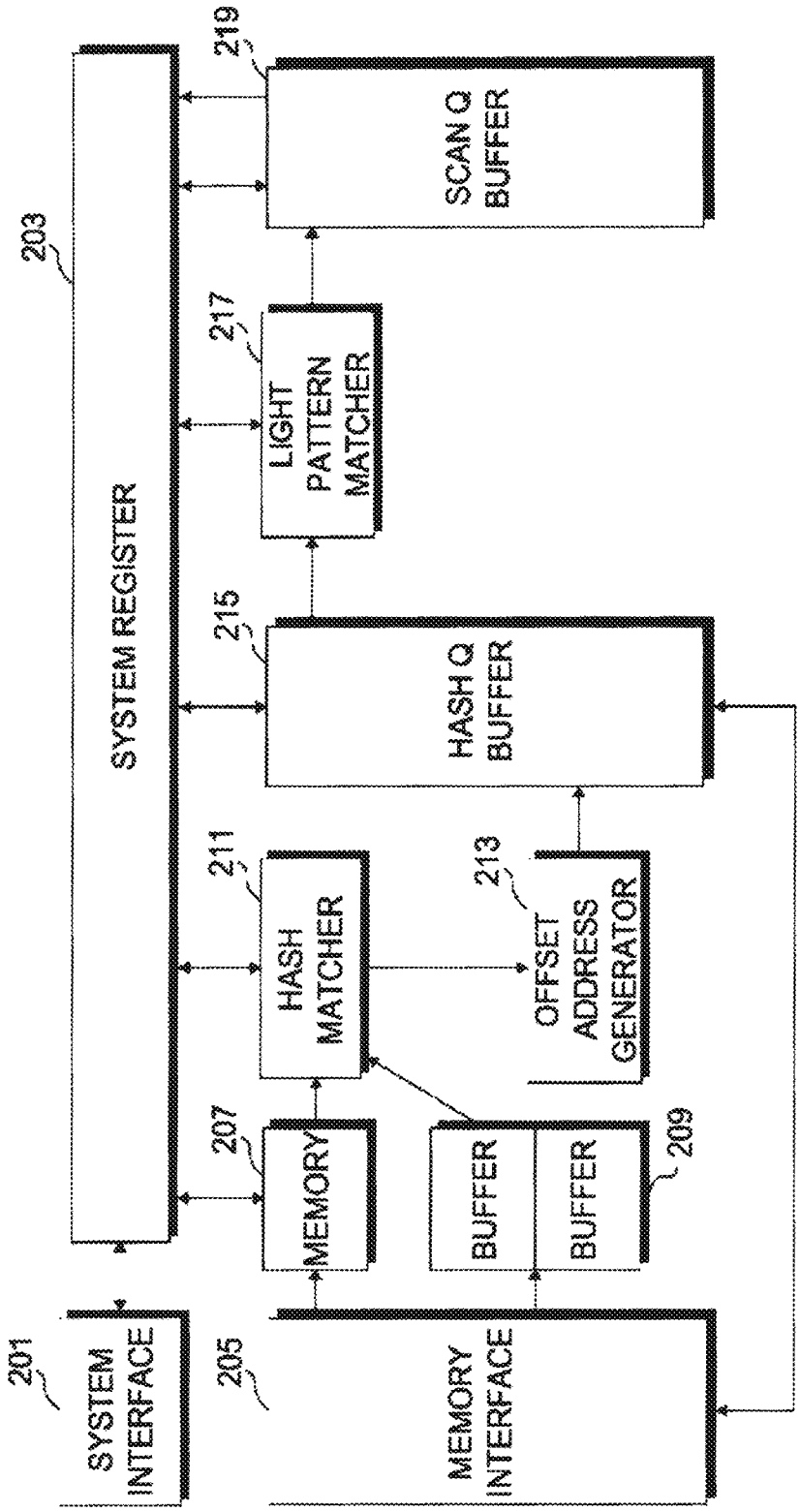

SYSTEM INTERFACE
201
MEMORY INTERFACE
205
SYSTEM REGISTER
203
MEMORY
207
BUFFER
BUFFER
209
HASH MATCHER
211
OFFSET ADDRESS GENERATOR
213
HASH Q BUFFER
215
LIGHT PATTERN MATCHER
217
SCAN Q BUFFER
219

FIG. 14

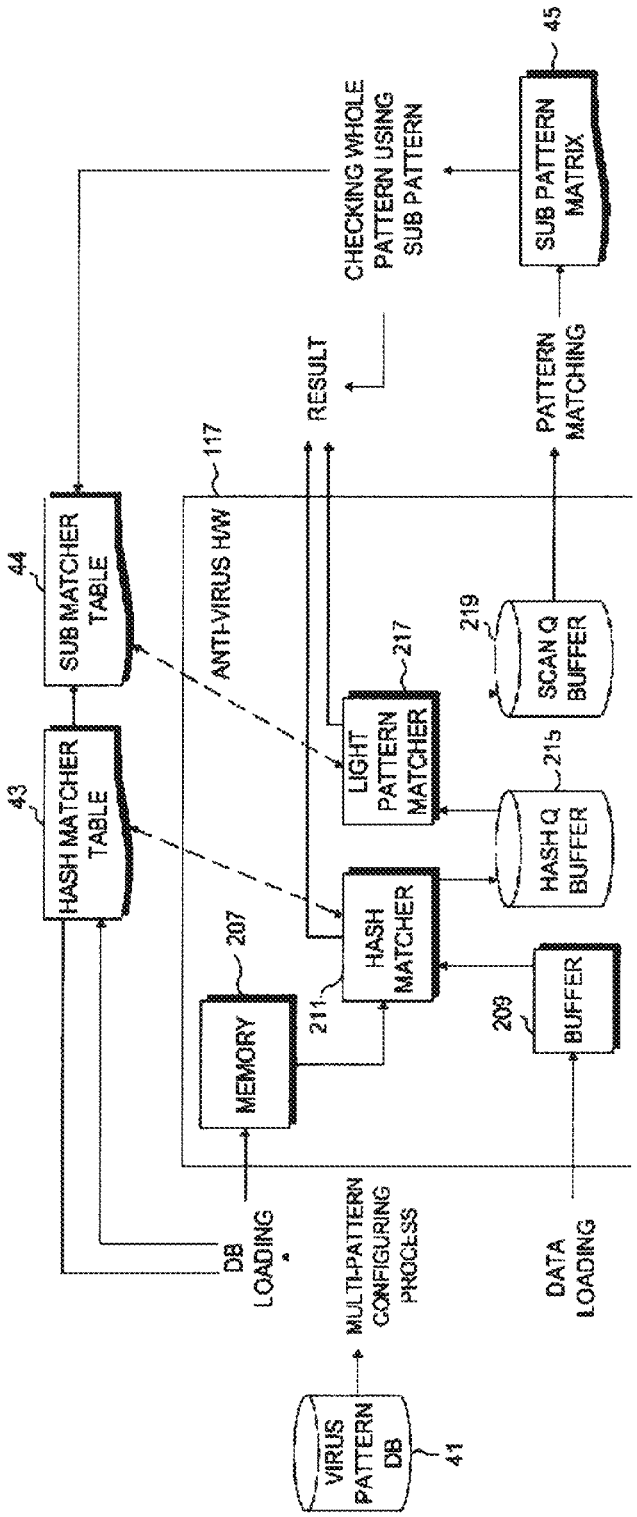

VIRUS PATTERN DB
41
MULTI-PATTERN CONFIGURING PROCESS
DB LOADING
DATA LOADING
MEMORY
207
211
HASH MATCHER
BUFFER
209
HASH Q BUFFER
215
LIGHT PATTERN MATCHER
217
SCAN Q BUFFER
219
HASH MATCHER TABLE
43
SUB MATCHER TABLE
44
ANTI-VIRUS H/W
117
RESULT
CHECKING WHOLE PATTERN USING SUB PATTERN
PATTERN MATCHING
SUB PATTERN MATRIX
45

FIG. 15

FIG. 16

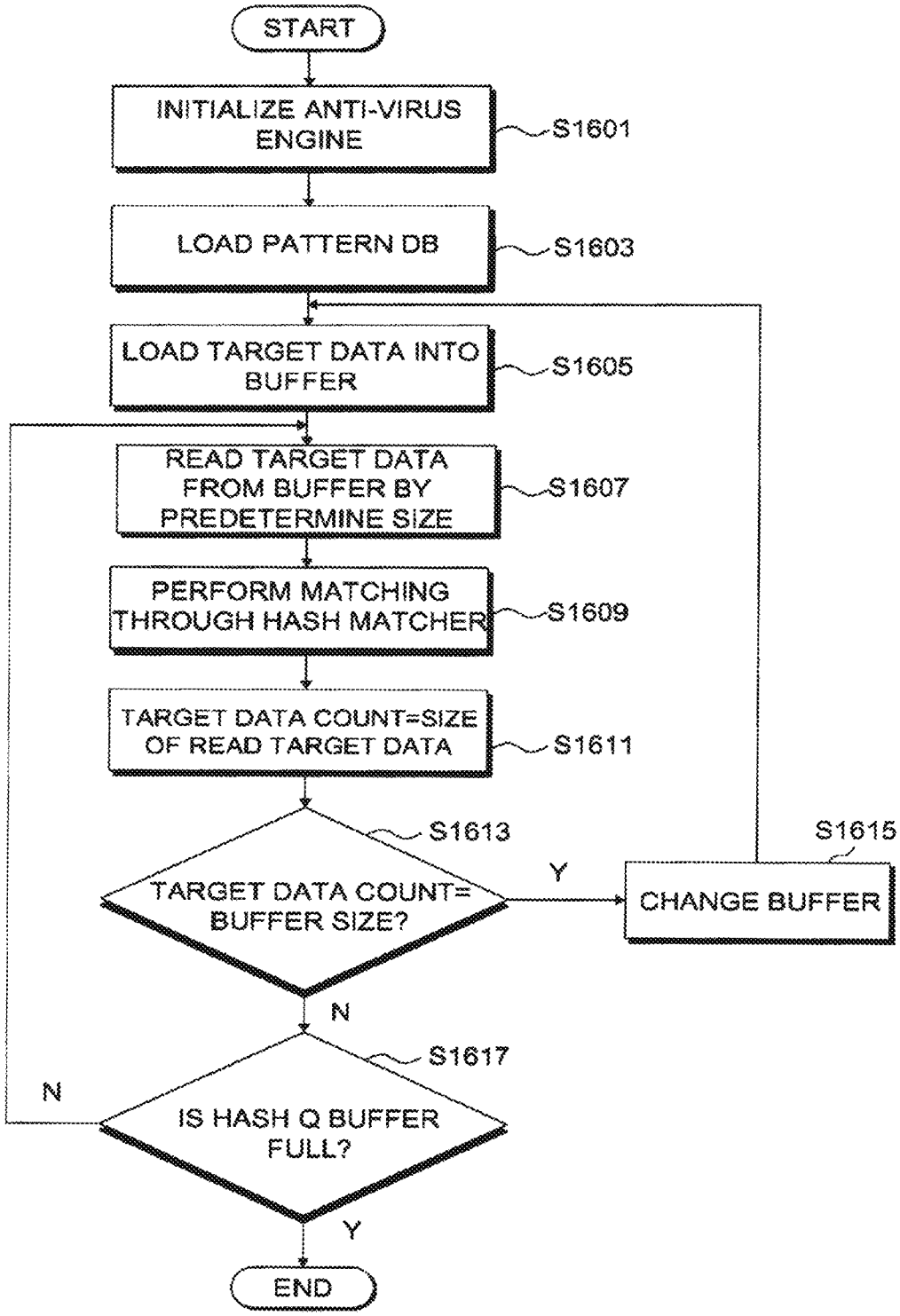

START
INITIALIZE ANTI-VIRUS ENGINE
S1601
LOAD PATTERN DB
S1603
LOAD TARGET DATA INTO BUFFER
S1605
READ TARGET DATA FROM BUFFER BY PREDETERMINE SIZE
S1607
PERFORM MATCHING THROUGH HASH MATCHER
S1609
TARGET DATA COUNT=SIZE OF READ TARGET DATA
S1611
S1613
TARGET DATA COUNT= BUFFER SIZE?
Y
S1615
CHANGE BUFFER
N
S1617
IS HASH Q BUFFER FULL?
N
Y
END

FIG. 17

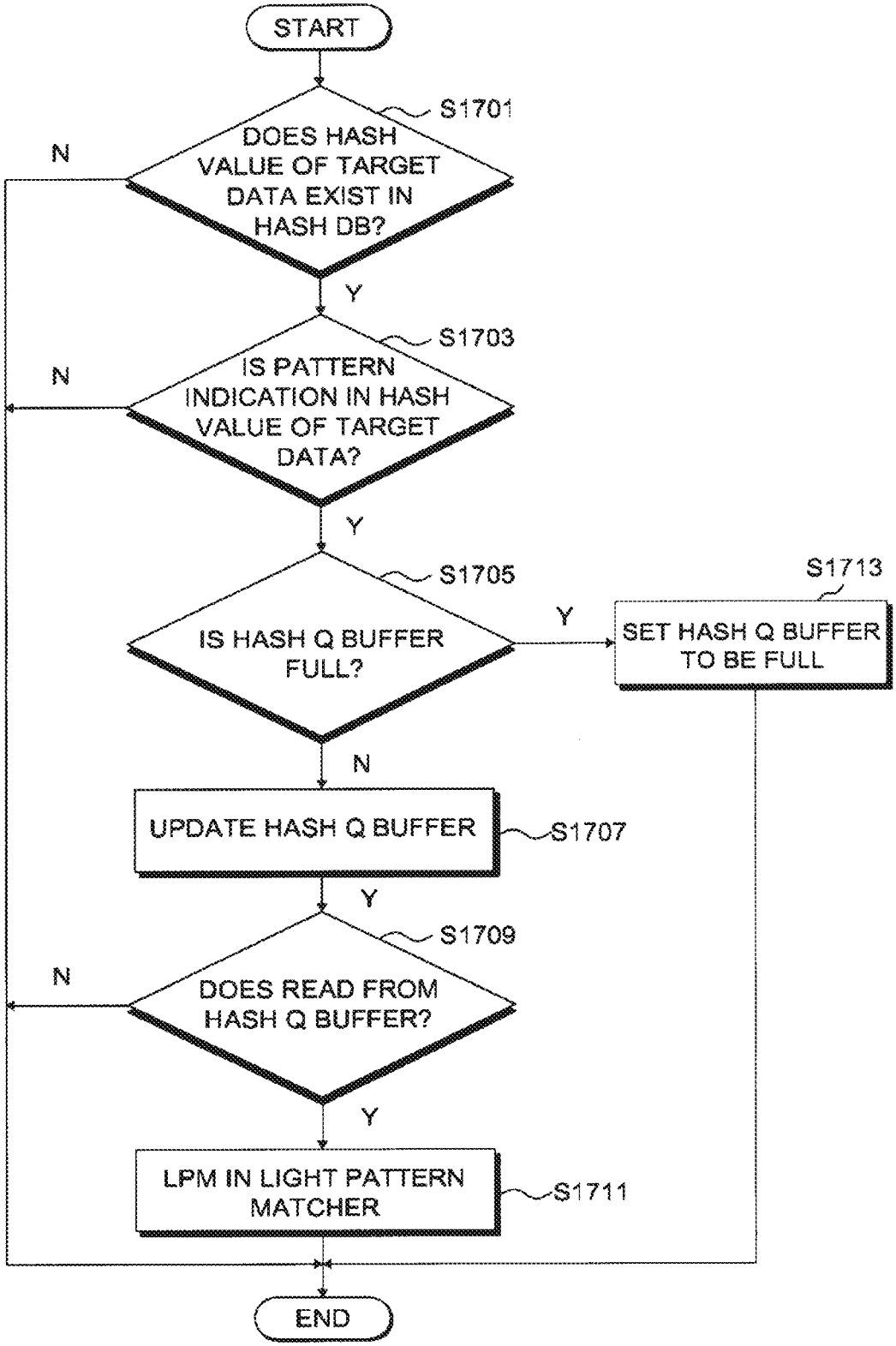
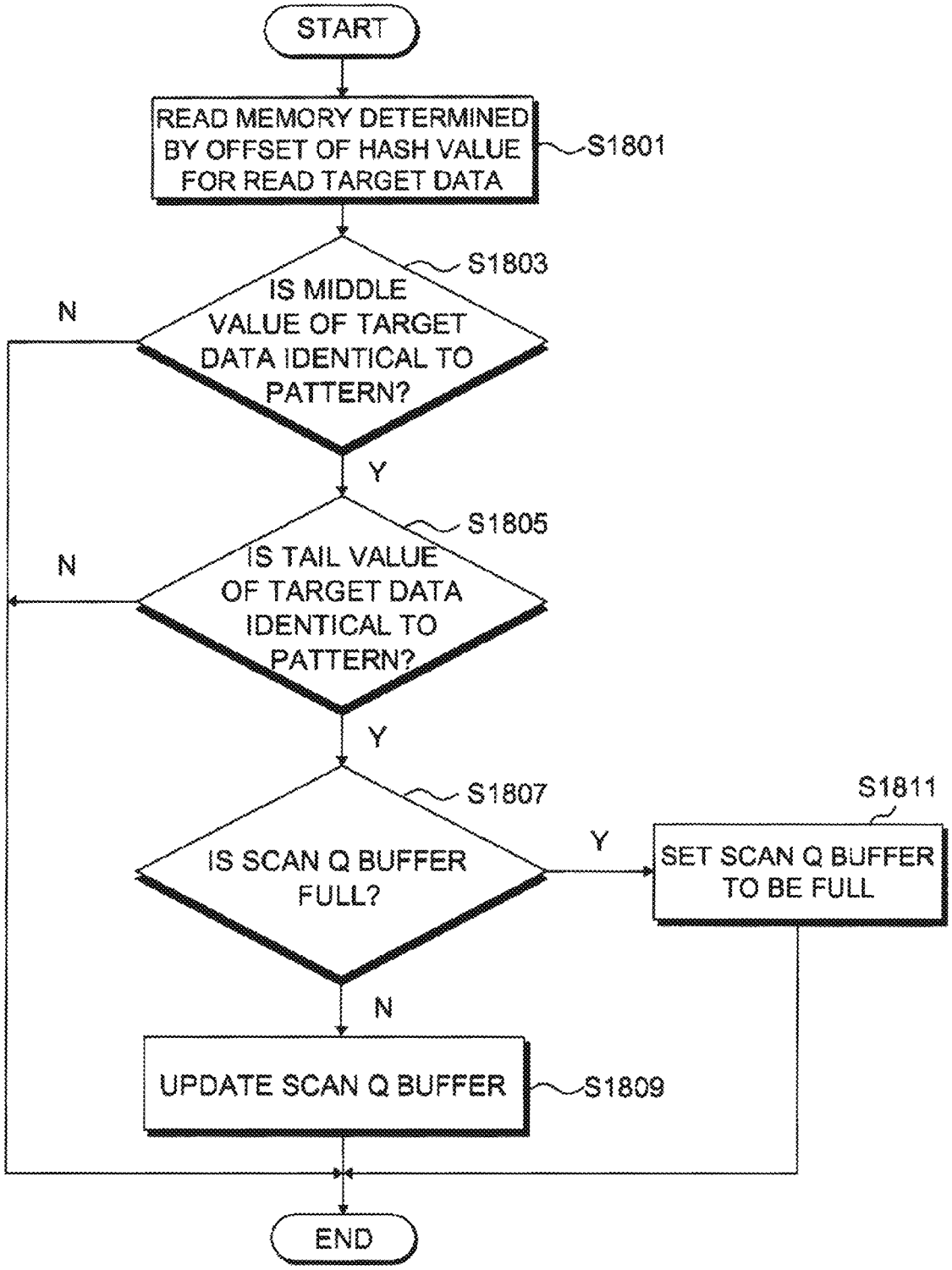

START
S1701
DOES HASH VALUE OF TARGET DATA EXIST IN HASH DB?
N
Y
S1703
IS PATTERN INDICATION IN HASH VALUE OF TARGET DATA?
N
Y
S1705
IS HASH Q BUFFER FULL?
Y
S1713
SET HASH Q BUFFER TO BE FULL
N
UPDATE HASH Q BUFFER
S1707
Y
S1709
DOES READ FROM HASH Q BUFFER?
N
Y
LPM IN LIGHT PATTERN MATCHER
S1711
END

FIG. 18


START
READ MEMORY DETERMINED BY OFFSET OF HASH VALUE FOR READ TARGET DATA
S1801
S1803
IS MIDDLE VALUE OF TARGET DATA IDENTICAL TO PATTERN?
N
Y
S1805
IS TAIL VALUE OF TARGET DATA IDENTICAL TO PATTERN?
N
Y
S1807
IS SCAN Q BUFFER FULL?
Y
S1811
SET SCAN Q BUFFER TO BE FULL
N
UPDATE SCAN Q BUFFER
S1809
END

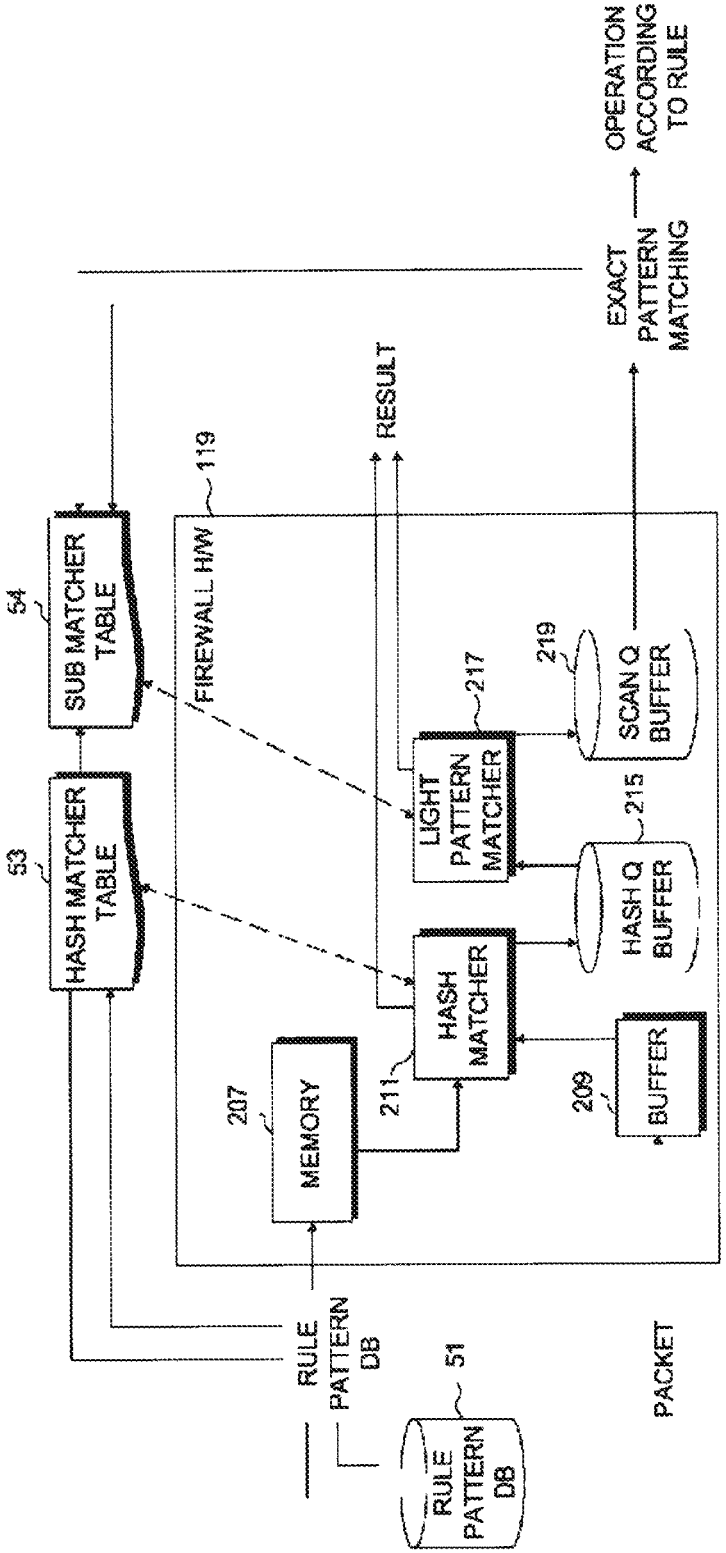

RULE PATTERN DB
51
RULE PATTERN DB
PACKET
53
HASH MATCHER TABLE
54
SUB MATCHER TABLE
FIREWALL H/W
119
MEMORY
207
HASH MATCHER
211
BUFFER
209
HASH Q BUFFER
215
LIGHT PATTERN MATCHER
217
SCAN Q BUFFER
219
RESULT
EXACT PATTERN MATCHING
OPERATION ACCORDING TO RULE

FIG. 19

FIG. 20

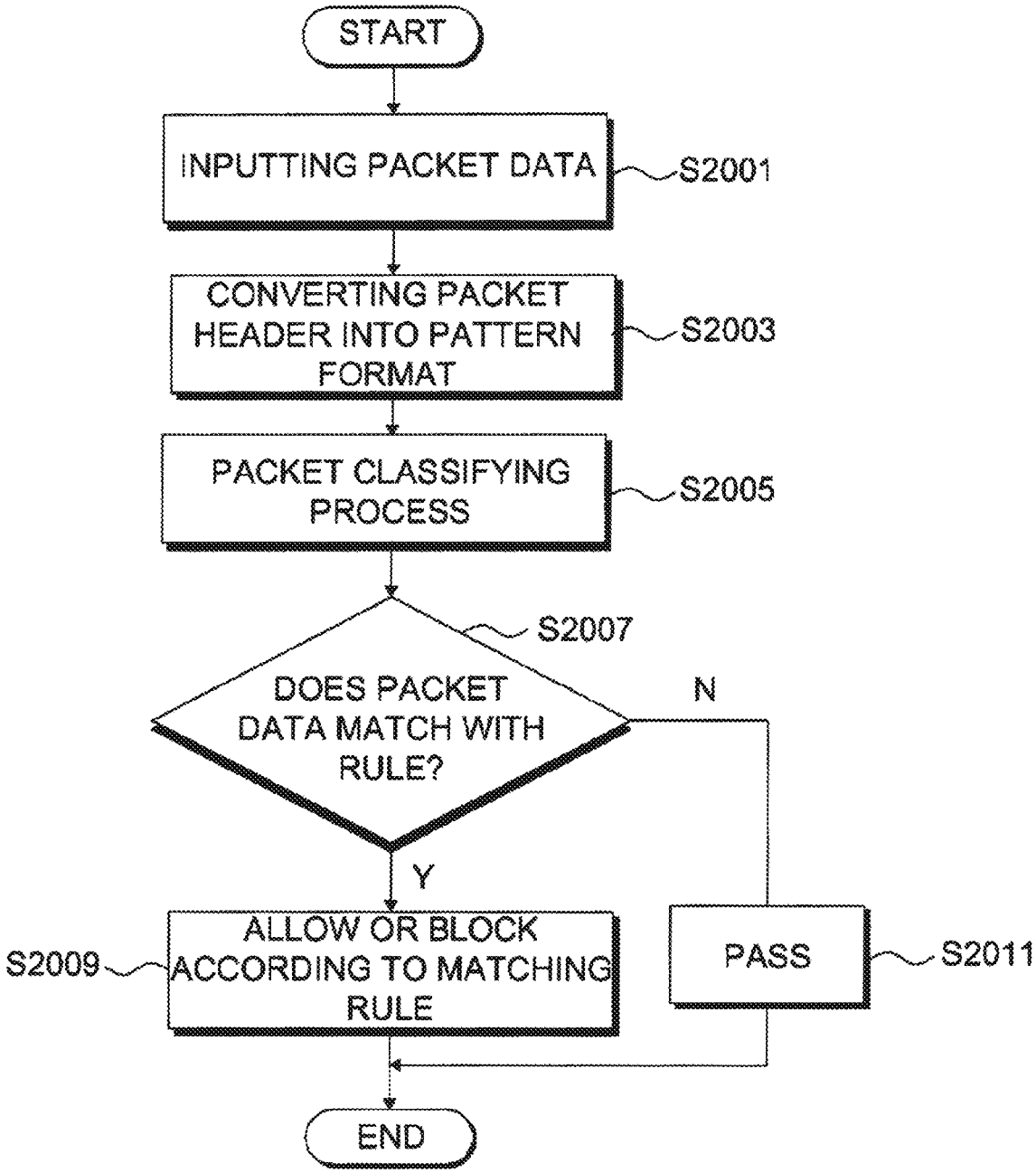

START
INPUTTING PACKET DATA
S2001
CONVERTING PACKET HEADER INTO PATTERN FORMAT
S2003
PACKET CLASSIFYING PROCESS
S2005
S2007
DOES PACKET DATA MATCH WITH RULE?
N
Y
ALLOW OR BLOCK ACCORDING TO MATCHING RULE
S2009
PASS
S2011
END

FIG. 21

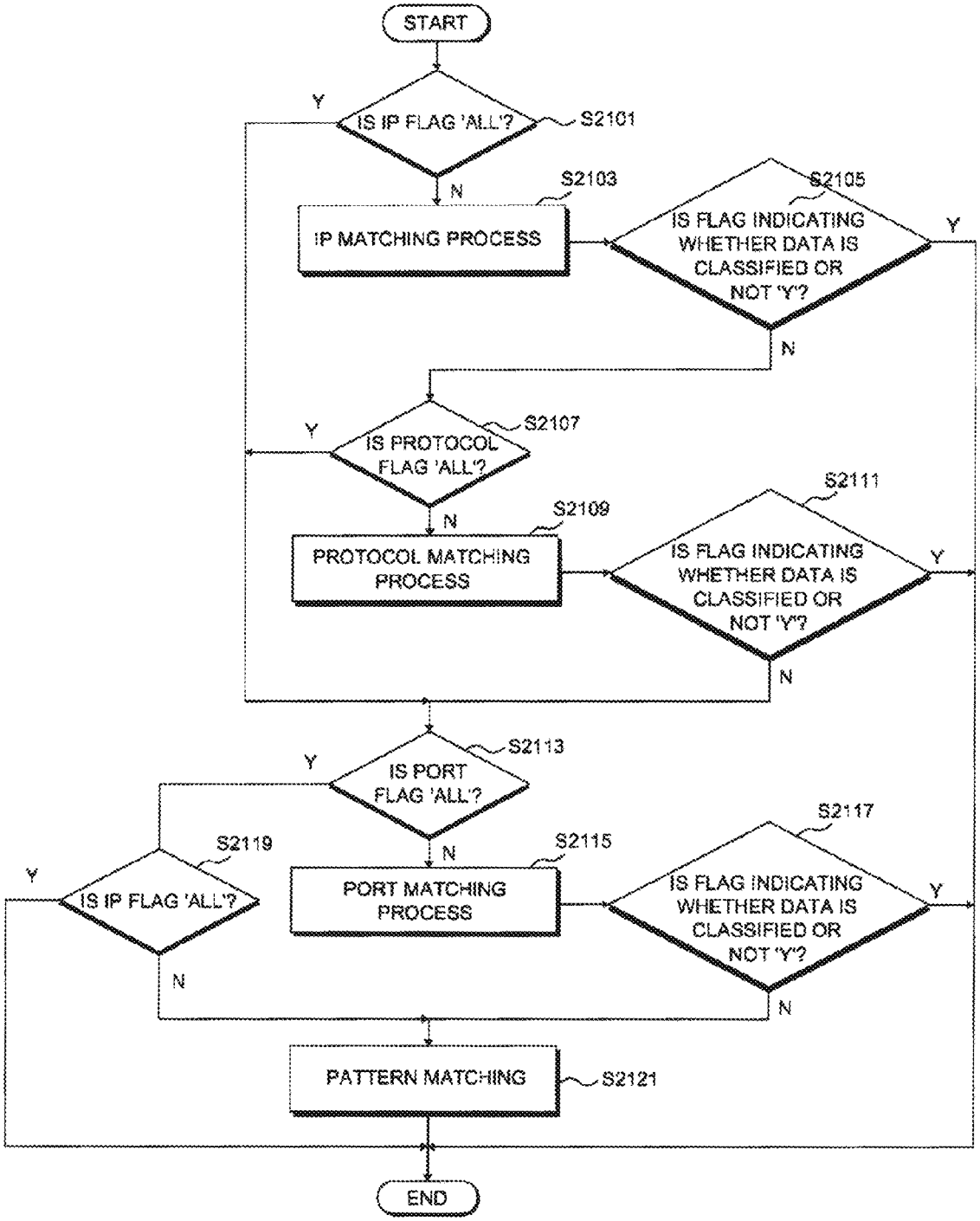

START
IS IP FLAG 'ALL'?
S2101
Y
N
IP MATCHING PROCESS
S2103
IS FLAG INDICATING WHETHER DATA IS CLASSIFIED OR NOT 'Y'?
S2105
Y
N
IS PROTOCOL FLAG 'ALL'?
S2107
Y
N
PROTOCOL MATCHING PROCESS
S2109
IS FLAG INDICATING WHETHER DATA IS CLASSIFIED OR NOT 'Y'?
S2111
Y
N
IS PORT FLAG 'ALL'?
S2113
Y
N
IS IP FLAG 'ALL'?
S2119
Y
N
PORT MATCHING PROCESS
S2115
IS FLAG INDICATING WHETHER DATA IS CLASSIFIED OR NOT 'Y'?
S2117
Y
N
PATTERN MATCHING
S2121
END

FIG. 22

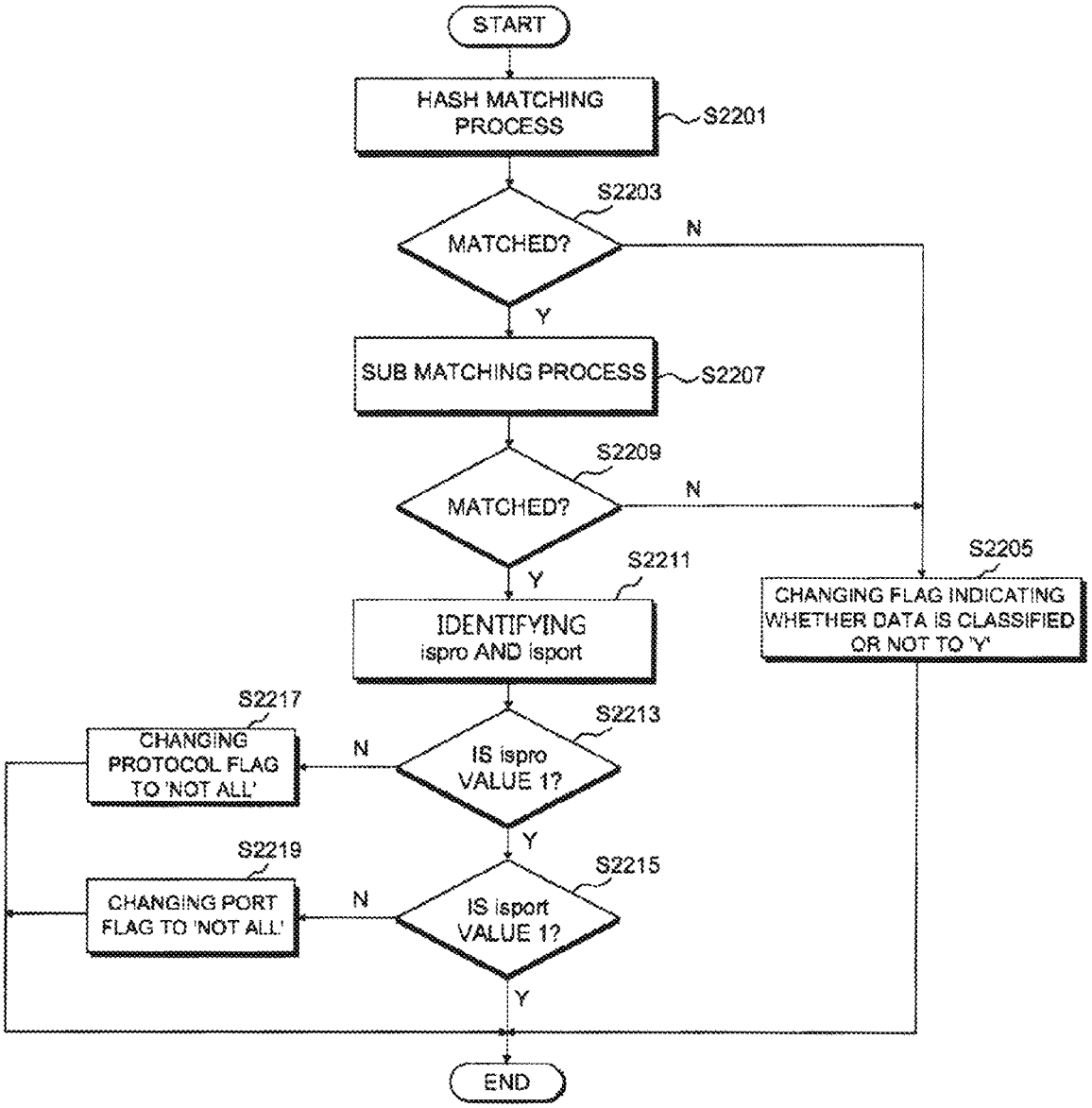

START
HASH MATCHING PROCESS
S2201
S2203
MATCHED?
N
Y
SUB MATCHING PROCESS
S2207
S2209
MATCHED?
N
Y
S2211
IDENTIFYING ispro AND isport
S2205
CHANGING FLAG INDICATING WHETHER DATA IS CLASSIFIED OR NOT TO 'Y'
S2217
CHANGING PROTOCOL FLAG TO 'NOT ALL'
N
S2213
IS ispro VALUE 1?
Y
S2219
CHANGING PORT FLAG TO 'NOT ALL'
N
S2215
IS isport VALUE 1?
Y
END

FIG. 23

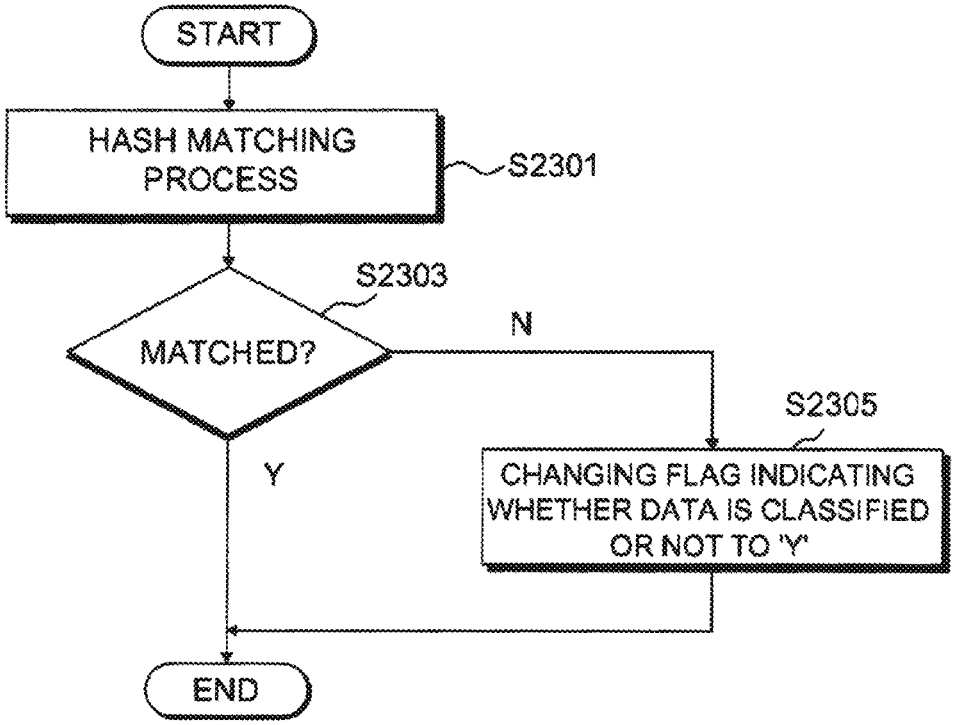

START
HASH MATCHING PROCESS
S2301
S2303
MATCHED?
N
Y
S2305
CHANGING FLAG INDICATING WHETHER DATA IS CLASSIFIED OR NOT TO 'Y'
END

FIG. 24

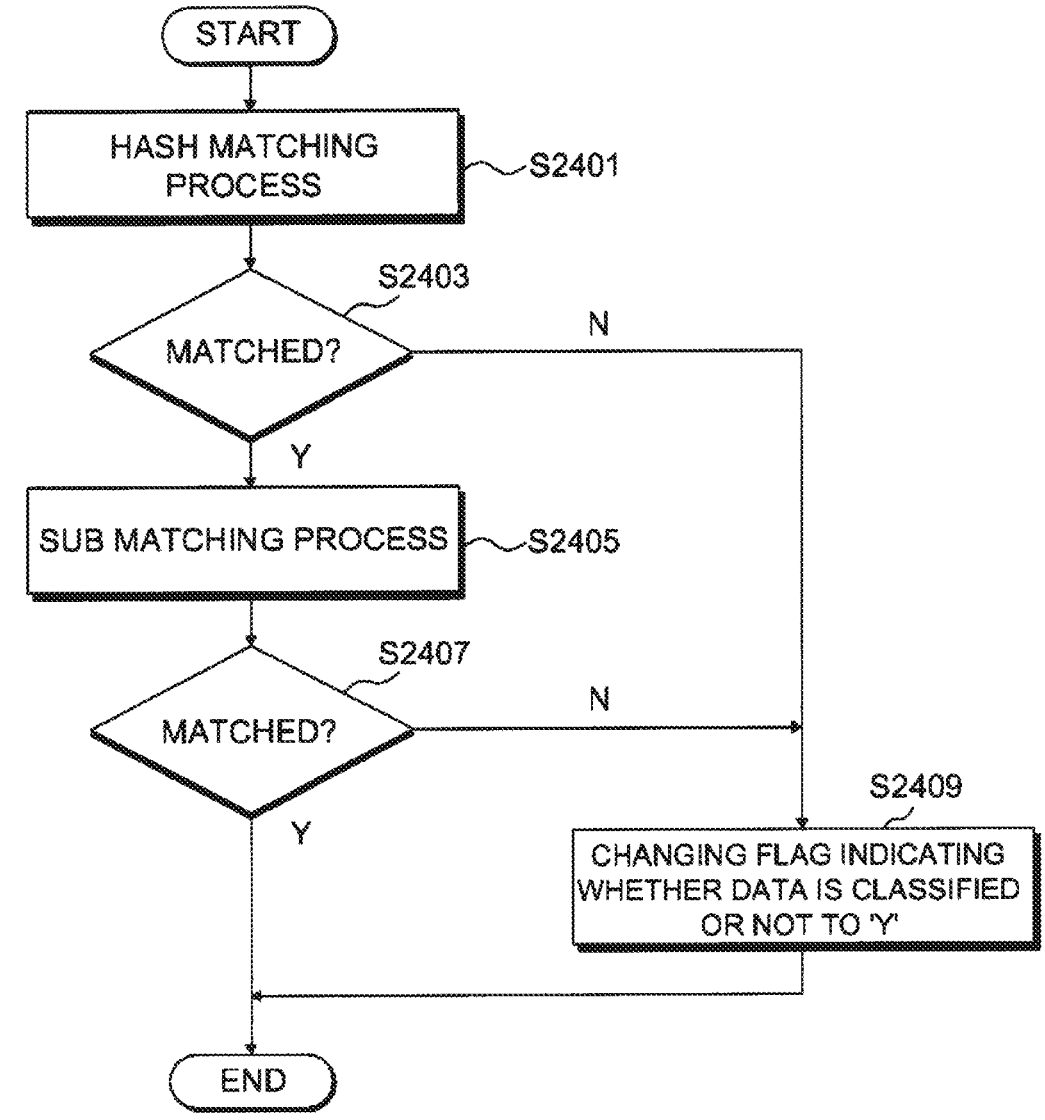

START
HASH MATCHING PROCESS
S2401
S2403
MATCHED?
N
Y
SUB MATCHING PROCESS
S2405
S2407
MATCHED?
N
Y
S2409
CHANGING FLAG INDICATING WHETHER DATA IS CLASSIFIED OR NOT TO 'Y'
END

FIG. 25

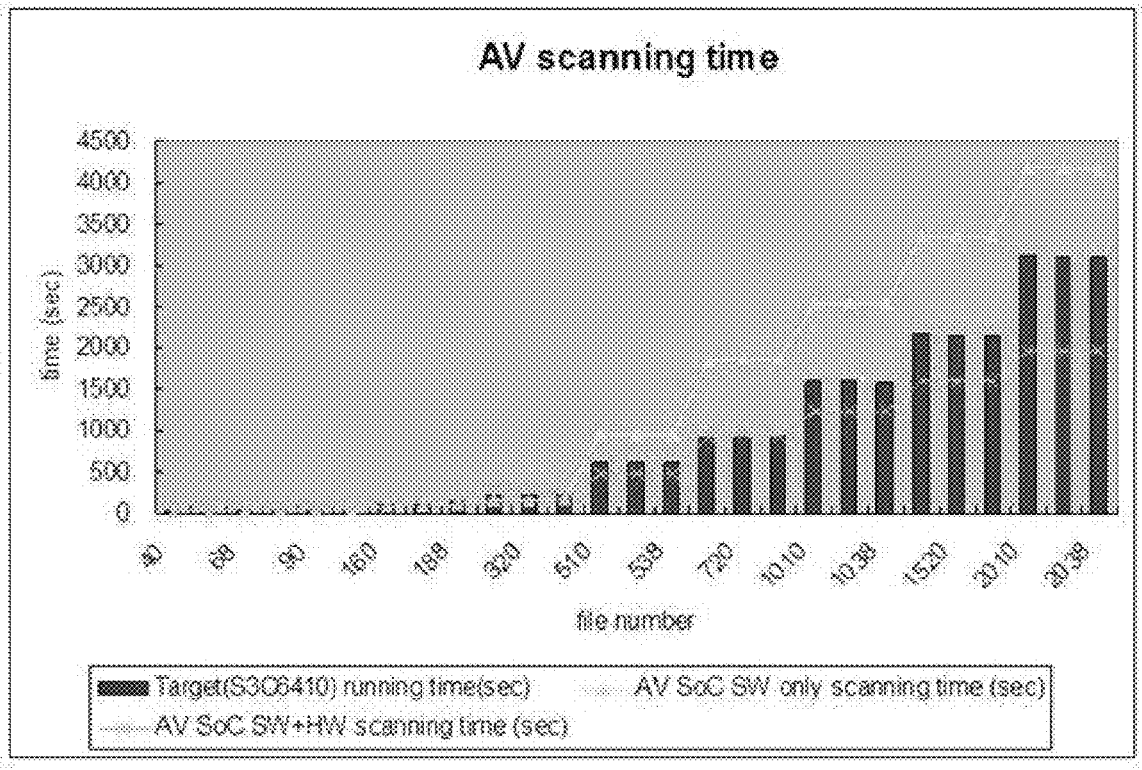

AV scanning time
time (sec)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
40
68
90
160
188
320
510
538
720
1010
1038
1520
2010
2038
file number
Target(S3C6410) running time(sec)
AV SoC SW only scanning time (sec)
AV SoC SW+HW scanning time (sec)

FIG. 26

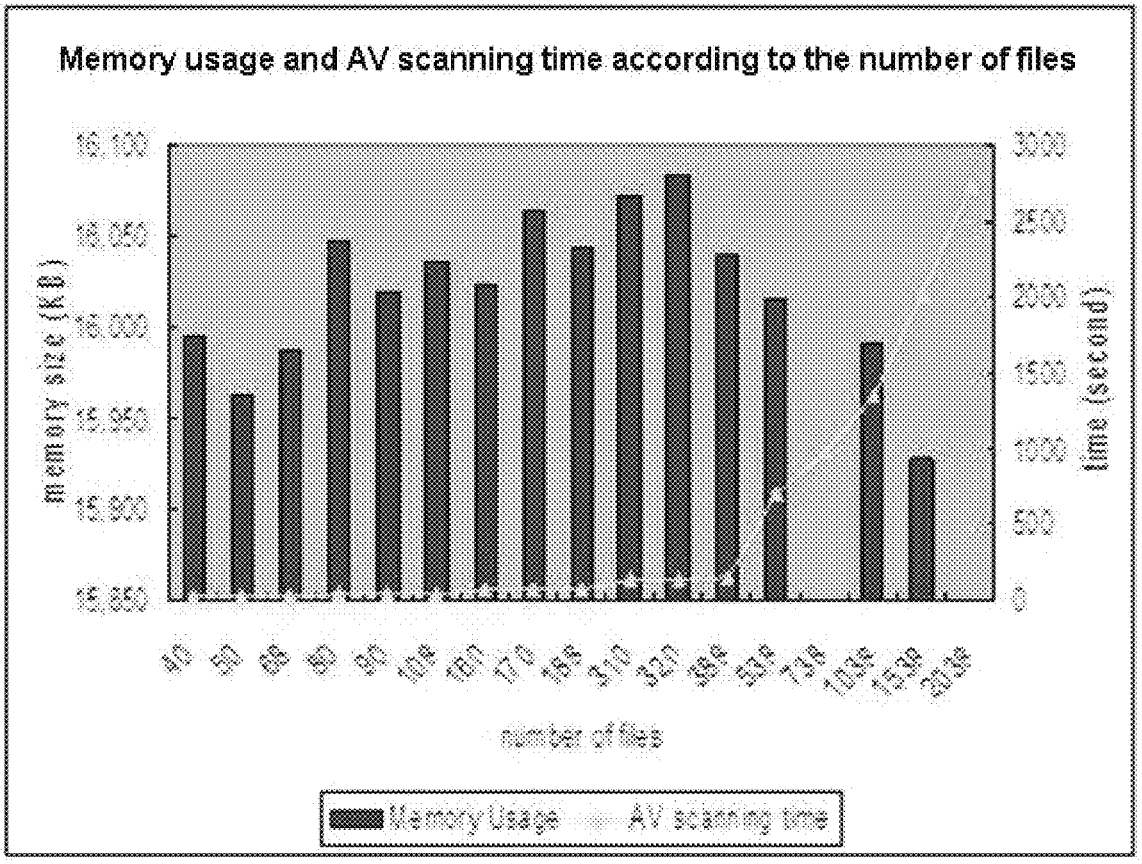

Memory usage and AV scanning time according to the number of files
16,100
16,050
16,000
15,950
15,900
15,850
memory size (KB)
3000
2500
2000
1500
1000
500
0
time (second)
number of files
Memory Usage
AV scanning time

FIG. 27

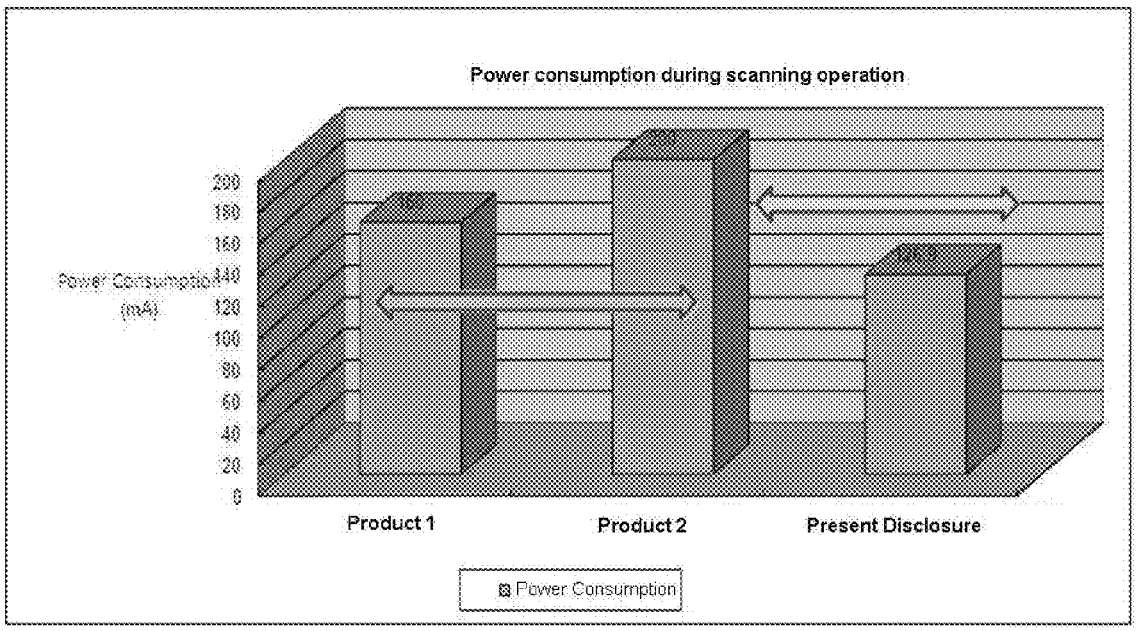

Power consumption during scanning operation
Power Consumption (mA)
200
180
160
140
120
100
80
60
40
20
0
Product 1
Product 2
Present Disclosure
Power Consumption

FIG. 28

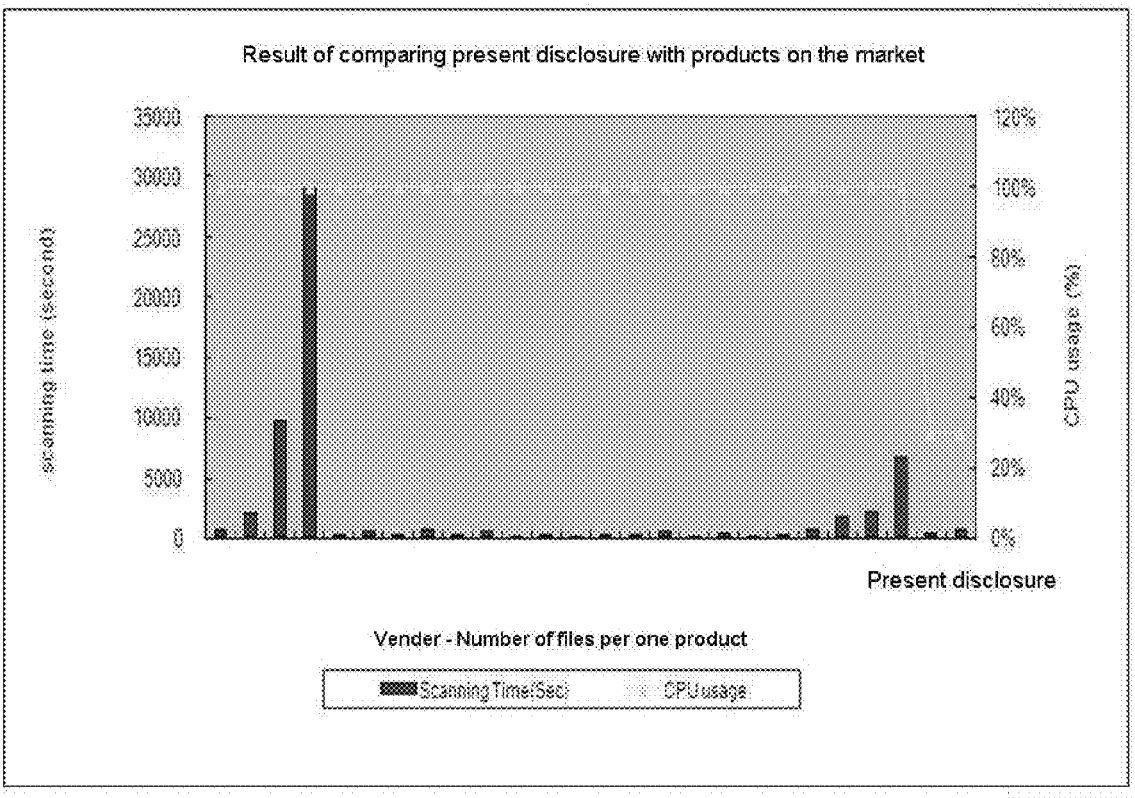
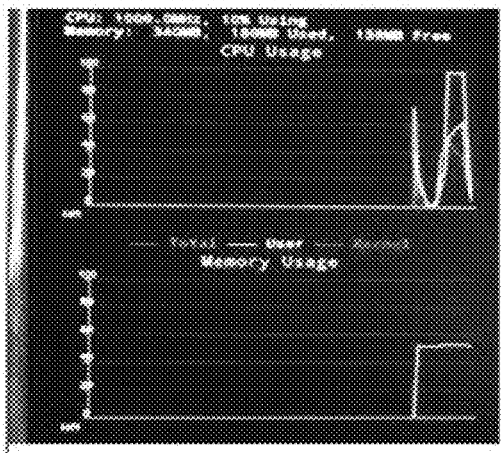
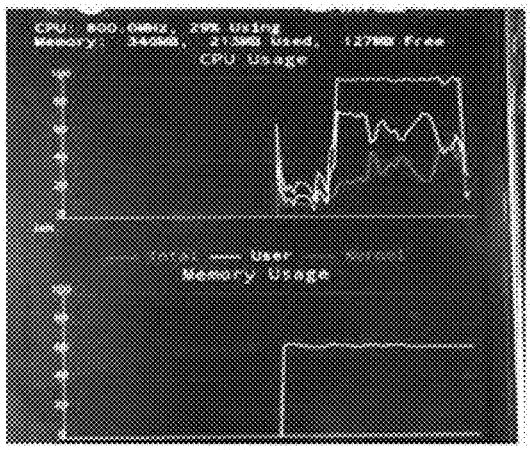

Result of comparing present disclosure with products on the market
35000
30000
25000
20000
15000
10000
5000
0
scanning time (second)
120%
100%
80%
60%
40%
20%
0%
CPU usage (%)
Present disclosure
Vender - Number of files per one product
Scanning Time(Sec)
CPU usage

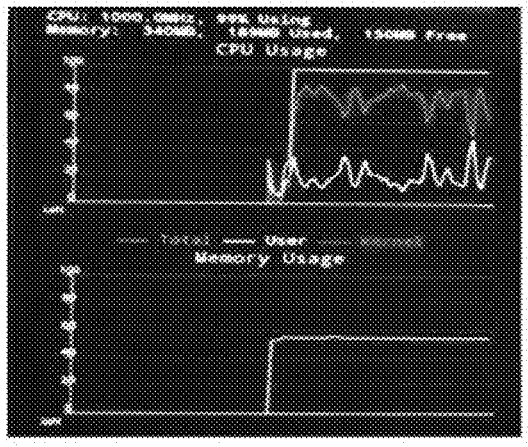
FIG. 29


CPU Usage
Memory Usage

(a)

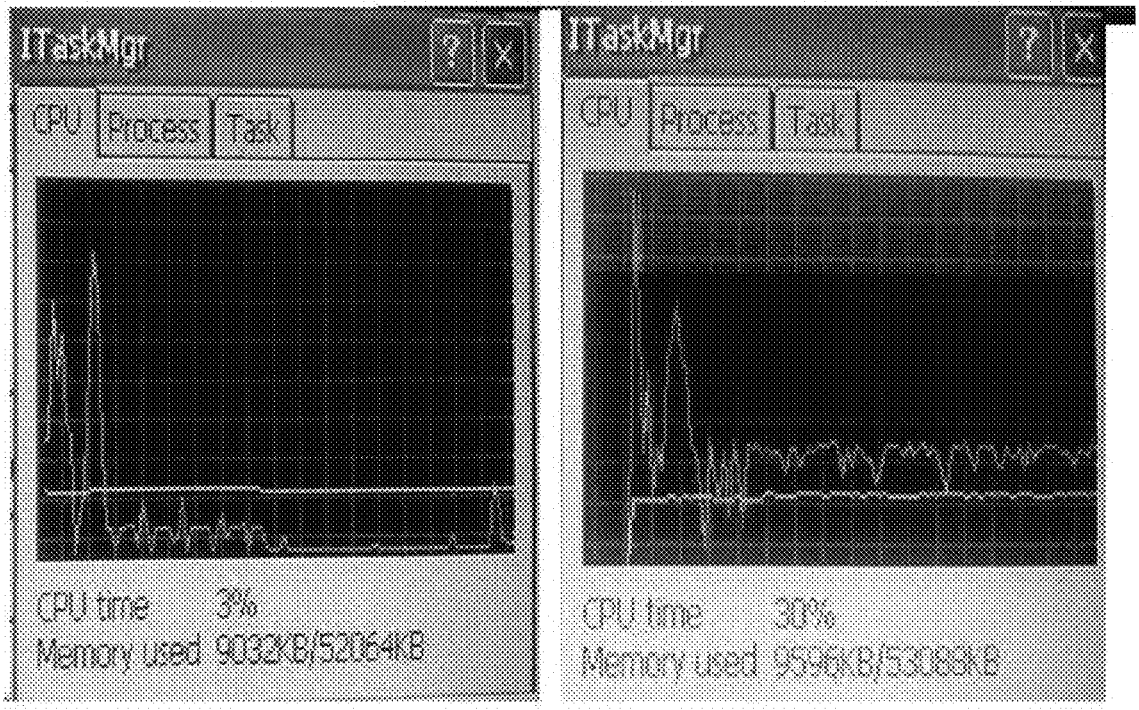

CPU Usage
Memory Usage

(b)


CPU Usage
Memory Usage

(c)

FIG. 30


TTaskMgr
CPU
Process
Task
CPU time 3%
Memory used 9032KB/53064KB
TTaskMgr
CPU
Process
Task
CPU time 30%
Memory used 9596KB/53083KB

(a) (b)

ANTI-MALWARE SYSTEM AND OPERATING METHOD THEREOF

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

This application claims priorities from Korean Patent Application No. 10-2010-0053371, filed on Jun. 7, 2010, Korean Patent Application No. 10-2010-0057824, filed on Jun. 18, 2010, and Korean Patent Application No. 10-2011-0051706, filed on May 30, 2011, in the Korean Intellectual Property Office, the disclosures of which are incorporated herein by reference in their entireties.

BACKGROUND

1. Field

Apparatuses and methods consistent with exemplary embodiments relate to anti-malware systems, and operating methods thereof, and more particularly, to anti-malware systems for swiftly filtering or scanning malware, and operating methods thereof.

2. Description of the Related Art

Malware is any software designed to damage a computer system, such as computer viruses, Trojan horses, malicious codes, and the like. As hardware of mobile devices has become more luxurious, and application programs embodied in portable terminals have become varied and more complicated, malware that has attacked typical computers is likely to seriously damage mobile devices. In particular, as wireless portable Internet services such as WiBro have been spread, mobile malware that attacks weak points of application programs and services, such as Bluetooth and multimedia messaging system (MMS), as well as malware that attacks weak points of application programs for typical computers has been introduced. These various malwares may seriously damage mobile devices, and for example, may cause operational errors of mobile devices, may delete data, and may invade user's privacy.

Typical anti-malware solutions are based on software, and have been used in mobile devices. As mobile devices need to include a control processing unit (CPU), a battery, and the like, there is a limit in using resources. Thus, when a mobile device uses the typical anti-malware solutions based on software, a user may experience some inconvenience due to reduced performance when performing another operation. In this case, when network packets are monitored, it is difficult to monitor all network packets due to the reduced performance.

SUMMARY

One or more aspects of exemplary embodiments provide anti-malware systems for swiftly filtering or scanning malware, and operating methods thereof.

One or more aspects of exemplary embodiments provide anti-malware systems for swiftly filtering and scanning malware in a mobile device having a limited resource, and operating methods thereof.

According to an aspect of an exemplary embodiment, there is provided an operating method of an anti-malware system, the operating method including: performing a filtering operation on data (hereinafter, referred to as 'first target data') to be filtered by matching the first target data with rule patterns; and performing a virus scanning operation on data (hereinafter, referred to as 'second target data') to be virus-scanned by matching the second target data with virus patterns, wherein the filtering operation and the scanning operation are performed on a system-on-chip (SoC).

According to an aspect of another exemplary embodiment, there is provided an anti-malware system for receiving target data, and at least one of scanning and filtering anti-malware, the anti-malware system including: a storage unit for storing a malware pattern; a first hash value matching unit for matching a hash value of at least a portion of the target data with a hash value of the malware pattern; and a first light pattern matching unit for matching the malware pattern with the portion of the target data, when the matching of the hash value is successful, wherein an light pattern matching operation is successful, the malware pattern is matched with whole of the target data.

BRIEF DESCRIPTION OF THE DRAWINGS

The patent or application file contains at least one drawing executed in color. Copies of this patent or patent application publication with color drawing(s) will be provided by the Office upon request and payment of the necessary fee.

The above and other features and advantages will become more apparent by describing in detail exemplary embodiments with reference to the attached drawings in which:

FIG. **1** is a block diagram of a mobile device including an anti-malware system, according to an exemplary embodiment;

FIG. **2** is a block diagram of the anti-malware system of FIG. **1**, according to an exemplary embodiment;

FIG. **3** is a functional block diagram for explaining an operation of a first anti-malware system, according to an exemplary embodiment;

FIG. **4** is a block diagram for explaining a firewall (FW) engine, an anti-virus (AV) engine, and a matching unit of FIG. **3**, according to an exemplary embodiment;

FIG. **5** shows a first hash matcher table and a first sub matcher table of FIG. **4**, according to an exemplary embodiment;

FIG. **6** shows an example of a pattern hash value table used in an AV engine, according to an exemplary embodiment;

FIG. **7** shows a second hash matcher table and a second sub matcher table, which are used by an AV engine of FIG. **4**, according to an exemplary embodiment;

FIG. **8** is a block diagram for explaining an operation of a second anti-malware system, according to another exemplary embodiment;

FIG. **9** is a block diagram for explaining an operation of a third anti-malware system, according to another exemplary embodiment;

FIG. **10** is a block diagram for explaining a FW engine, according to an exemplary embodiment;

FIG. **11** is a block diagram for explaining an AV engine, according to an exemplary embodiment;

FIG. **12** is a block diagram for explaining an operation of a fourth anti-malware system according to another exemplary embodiment;

FIG. **13** is a flowchart of an operating method of an anti-malware system, according to an exemplary embodiment;

FIG. **14** is a block diagram of a hardware configuration of the anti-virus hardware (H/W) of FIG. **2**, according to an exemplary embodiment;

FIG. **15** is a block diagram for explaining a virus scanning operation in an anti-virus H/W, according to an exemplary embodiment;

FIG. **16** is a flowchart of an operating method of the anti-virus H/W in an anti-malware system, according to an exemplary embodiment;

FIG. **17** is a flowchart of a matching operation of a hash matcher of Operation **S1609** of FIG. **16**, according to an exemplary embodiment;

FIG. **18** is a flowchart for explaining a matching operation of a light pattern matcher of Operation **S1711**, according to an exemplary embodiment;

FIG. **19** is a block diagram for explaining a packet filtering operation performed in a firewall H/W, according to an exemplary embodiment;

FIG. **20** is a flowchart of a packet filtering method of a FW engine, according to an exemplary embodiment;

FIG. **21** is a flowchart of a packet dividing process of Operation **S2003**, according to an exemplary embodiment;

FIG. **22** is a flowchart of an IP matching process of Operation **S2103**, according to an exemplary embodiment;

FIG. **23** is a flowchart of a protocol matching process of Operation **S2109**, according to an exemplary embodiment; and

FIG. **24** is a flowchart of a port matching process of Operation **S2115**, according to an exemplary embodiment.

FIGS. **25** to **30** are views to explain effects of the SOC according to exemplary embodiments.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Exemplary embodiments will now be described more fully with reference to the accompanying drawings to clarify aspects, features and advantages. Exemplary embodiments may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, these exemplary embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the inventive concept to those of ordinary skill in the art. It will be understood that when an element, layer or region is referred to as being "on" another element, layer or region, the element, layer or region can be directly on another element, layer or region or intervening elements, layers or regions.

The terms used herein are for the purpose of describing particular embodiments only and are not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, layers, regions, elements, components, and/or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, operations, layers, regions, elements, components, and/or groups thereof. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. Furthermore, expressions such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

As the inventive concept allows for various changes and numerous embodiments, particular exemplary embodiments will be illustrated in the drawings and described in detail in the written description. However, this is not intended to limit the present inventive concept to particular modes of practice, and it is to be appreciated that all changes, equivalents, and substitutes that do not depart from the spirit and technical scope of the present inventive concept are encompassed in the present inventive concept. In the description of the exemplary embodiment, certain detailed explanations of related art are omitted when it is deemed that they may unnecessarily obscure the essence of the inventive concept.

According to one or more exemplary embodiments, an anti-malware system functioning as anti-malware may be embodied in the form of a single chip based on a system on chip (SoC), or in the form of a single IP chip in a typical application processor.

Various mobile devices including cellular phones, smart phones, and tablet PCs have no standard for an interface between components, and have various models according to a function. Thus, exemplary embodiments described herein are just examples, and may be changed in various ways according to an interface situation. Hereinafter, exemplary embodiments will be described in terms of a mobile device. However, a computing device such as a general personal computer (PC) may also be used.

FIG. **1** is a block diagram of a mobile device including an anti-malware system **100**, according to an exemplary embodiment.

Referring to FIG. **1**, the anti-malware system **100** may be embodied in the form of a single chip, and may be installed in the mobile device. Data and address signals, read and write signals, and control signals may be transmitted between the anti-malware system **100** and a mobile processor **10**.

The anti-malware system **100** communicates with a debug port **20** through a general purpose input/output pin (GPIO) and a universal asynchronous receiver transmitter (UART) for debugging.

The anti-malware system **100** may include a serial peripheral interface (SPI) for communication with peripheral devices including a network interface card (NIC) **30**.

The anti-malware system **100** may include a GPIO for interrupt handling such as a wireless land (WiFi) **40**.

FIG. **2** is a block diagram of the anti-malware system **100** of FIG. **1**, according to an exemplary embodiment.

Referring to FIG. **2**, the anti-malware system **100** includes configure buses **101** and **125**, a central processing unit (CPU) **103**, a direct memory access (DMA) controller **105**, local buses **107** and **131**, a synchronous dynamic random access memory (SDRAM) controller **109**, a flash controller **111**, a static random access memory (SRAM) controller **113**, a buffer **115**, an anti-virus hardware (H/W) **117**, a firewall H/W **119**, a bus matrix **121**, and a boot **123**. The anti-malware system **100** may further include a SDRAM **127**, a flash memory **129**, and a SRAM **130**. Although the exemplary embodiments have descriptions for viruses, these embodiments are merely exemplary in that the same exemplary embodiments may be applied for other malware, e.g., used to scan for other malware, and are not limited to viruses.

The CPU **103** controls overall operations of the anti-malware system **100**, and processes requested operations. According to an exemplary embodiment, the CPU **103** may be a reconfigurable CPU, but this is merely an example. Thus, a CPU that is not reconfigurable may also be used.

The DMA controller **105** controls a DMA.

In FIG. **2**, a memory controller may include the SDRAM controller **109**, the flash controller **111**, and the SRAM controller **113**. The SDRAM controller **109** controls an input and output of the SDRAM **127**. The flash controller **111** controls an input and output of the flash memory **129**. The SRAM controller **113** controls an input and output of the SRAM **130**.

The buffer **115** temporarily stores data through an interface with an external component.

The anti-virus H/W **117** may perform a matching operation between a virus pattern and target data to be virus-scanned. For example, a virus pattern database (DB) may be stored in

the SRAM **130**, and the anti-virus H/W **117** may perform the matching operation between the virus pattern DB and the target data.

The firewall H/W **119** may be embodied as hardware, and may match target data to be filtered with a rule pattern DB. For example, the rule pattern DB may be stored in the SRAM **130**, and the firewall H/W **119** may match the rule pattern DB with the target data. Software for driving the anti-virus H/W **117** or software for driving the firewall H/W **119** is loaded into any of the SDRAM **127**, the flash memory **129**, and the SRAM **130**, and controls the anti-virus H/W **117** and the firewall H/W **119**.

A bus for transmitting data between blocks in the anti-malware system **100** may be divided into the local buses **107** and **131** for swift transmission of data, and the configure buses **101** and **125** for configuration. According to the present exemplary embodiment, the local bus **107**, and the configure buses **101** and **125** may meet an advanced high performance bus (AHB) standard.

The bus matrix **121** converts a control signal and a data signal of the AHB standard into a control signal and a data signal of an advanced peripheral bus (APB) standard or converts a control signal and a data signal of the APB standard into a control signal and a data signal of the AHB standard, and transmits the converted signals.

The boot **123** initializes the anti-malware system **100** in a SoC.

Updating the anti-malware software (SW) to a higher version may occur when there is a significant fix of a bug or an error, or when a security loophole is discovered in the anti-malware SW.

Referring to FIG. **1**, the updated binary may be received through the Network Interface Part, the SPI or the GPIO.

The following explains the operation of updating the anti-malware SW. The received binary update is stored at the mobile processor **10**. At the application level, the binary update is sent to the anti-malware SoC (e.g., Anti-Malware System **100** of FIG. **1**) through the anti-malware SoC API.

The binary update sent to the anti-malware SoC is saved through two methods.

In one method, the binary update is stored at the flash memory after having passed through the SRAM (FIG. **1**), and then stored in the boot area **123** (FIG. **2**).

In another method, the binary update received through the SRAM is stored in the boot area **123**.

To utilize the binary update, as the bootloader operates, the updated Anti-Malware SW is loaded to the DRAM, and through the CPU, anti-malware SW is run.

Hereinafter, anti-malware systems according to various exemplary embodiments will be described with reference to FIGS. **3** through **11**. FIGS. **3** through **11** are diagrams for explaining first through fourth anti-malware systems **300**, **800**, **900**, and **1200**, according to other exemplary embodiments. The first through fourth anti-malware systems **300**, **800**, **900**, and **1200** are each a modified exemplary embodiment of the anti-malware system **100** described with reference to FIGS. **1** and **2**.

The first through fourth anti-malware systems **300**, **800**, **900**, and **1200** may be embodied in the form of SoC, or may be installed in a telecommunicable device itself, such as PCs and mobile devices. Thus, devices including the first through fourth anti-malware systems **300**, **800**, **900**, and **1200** may each include a driver (not shown) and an application unit (not shown) to use the first through fourth anti-malware systems **300**, **800**, **900**, and **1200**. That is, in order to operate the first through fourth anti-malware systems **300**, **800**, **900**, and **1200** in the devices, the driver may be installed on each of the first through fourth anti-malware systems **300**, **800**, **900**, and **1200**, and the application unit may be installed on the driver, according to a hierarchical structure in terms of software.

FIG. **3** is a functional block diagram for explaining an operation of the first anti-malware system **300**, according to an exemplary embodiment.

Referring to FIG. **3**, the first anti-malware system **300** may include a manager **310**, a rule pattern DB **320**, a virus pattern DB **330**, a firewall (FW) engine **340**, a matching unit **350**, and an anti-virus (AV) engine **360**.

The manager **310** is in charge of setting operations related to a rule, generation/deletion/adding/change of the rule pattern DB **320** and update (generation/deletion/adding/change) of the virus pattern DB **330**, and processes a user command. The user command may be, for example, a command related to update of a firewall engine or an anti-virus engine.

An operation of generating the rule pattern DB **320**, which is performed by the manager **310**, will now be described. The manager **310** may include a rule list and a command list, which are data structures, and may include a FW commander and a rule manager, for processing these data structures.

When a user performs firewall rule setting through a user interface (UI) provided by FW application, the FW commander adds a command corresponding to the user's setting to the command list of the manager **310**, and wakes up the manager **310**. If the command added to the command list is a rule adding command, the FW commander may generate rule patterns based on information contained in a data field of the rule adding command, and may add the rule patterns to the rule list. In addition, when a rule applying command is added to the command list, the FW commander may call a rule manager, and may generate or update the rule pattern DB **320** based on the rule patterns stored in the rule list.

The rule pattern DB **320** is an aggregate of rule patterns for determining whether to allow a packet. The rule pattern DB **320** may be generated by receiving a list about a rule from a user application, which is performed by he manager **310**. In addition, the manager **310** may load the rule pattern DB **320** into a predetermined memory (or a buffer) so that the FW engine **340** may use the rule pattern DB **320**.

Alternatively, a user application itself transmits the rule pattern DB **320** to the manager **310**, and the manager **310** may receive the rule pattern DB **320** and may load the rule pattern DB **320** into a predetermined memory (or a buffer) so that the FW engine **340** may use the rule pattern DB **320**.

The rule pattern DB **320** may be provided by converting rule patterns set by a user in a predetermined form. The rule patterns may contain information about whether to allow or block the target data. Thus, the rule pattern DB **320** or the rule patterns are used for the FW engine **340** to determine whether to allow or block the target data transmitted from an external source. The rule pattern DB **320** may be used for the FW engine **340** to generate respective hash values of the rule patterns, and may be used to perform hash-value matching, light pattern matching (LPM), and exact pattern matching (EPM).

The virus pattern DB **330** is an aggregate of virus patterns, and may be used for the AV engine **360** to perform virus scanning. The manager **310** may receive a virus pattern DB from an AV application (not shown), and may store the virus pattern DB in a predetermined storage unit. The manager **310** may update the stored virus pattern DB.

The virus patterns may be used for the AV engine **360** to perform a matching operation with the target data in order to detect whether the target data is virus-infected. The rule pattern DB **320** and the virus pattern DB **330** may be stored in a

memory (e.g., the flash memory **129** of FIG. **2**) included in the SoC, or a separate memory (not shown).

In detail, the virus pattern DB **330** may be used for the AV engine **360** to generate respective hash values for the virus patterns, or may be used for the AV engine **360** to perform LPM, EPM and FPM by using the target data and the virus patterns. The virus pattern DB **330** may be a collection of pattern data of a grammatically defined simple pattern, a collection of pattern data of a grammatically complex pattern, or a mixture of the pattern data of the grammatically simple pattern and the pattern data of the grammatically complex pattern. The grammatically defined simple pattern or the grammatically complex pattern may be as defined in Korean Patent Application No. 10-2010-0049566 (filed on May 27, 2010) and Korean Patent Application No. 10-2010-0052981 (filed on Jun. 4, 2010). These documents are hereby incorporated by reference to the same extent unless otherwise indicated herein or otherwise clearly contradicted by context.

According to the present exemplary embodiment, the manager **310** may analyze a command or data transmitted from the user application, and may perform an operation corresponding to the command or data.

For example, when the manager **310** receives a command related to a scanning operation, the manager **310** may operate the AV engine **360**. When the manager **310** receives a command of updating the virus pattern DB **330**, the manager **310** may update the virus pattern DB **330**. In addition, the manager **310** may receive a file to be scanned from the user application, may order the AV engine **360** to perform the scanning operation, and may transmit the scanning result of the AV engine **360** to the user application.

With regard to an operation of the FW engine **340**, when the manager **310** receives a command for reporting a filtering result from the user application, the manager **310** may transmit the filtering result of the FW engine **340** to the user application in response to the command.

When the manager **310** receives a command or data from an application, the manager **310** determines whether the command or data is related to scanning or filtering, and then performs an operation corresponding to the determining result.

For example, when the manager **310** receives a scanning command, the manager **310** may operate the AV engine **360** to perform a scanning operation. Target data may be output from a web browser or an application unit (not shown) for generating and managing various files. When the target data is in the form of a file, the manager **310** may determine that virus scanning is to be performed on the target data, and the manager **310** may transmit the target data to the AV engine **360**. In this case, the manager **310** may control the AV engine **360** to perform the virus scanning on the target data. In addition, the manager **310** may receive virus patterns to be updated from an application unit (not shown), the manager **310** may update the virus pattern DB **330** by using the input virus patterns. The manager **310** may be divided into a FW manager for managing or controlling the FW engine **340**, and an AV manager for managing or controlling the AV engine **360**.

Hereinafter, the target data to be filtered will be referred to as 'first target data', and the target data to be virus-scanned will be referred to as 'second target data'.

The matching unit **350** may selectively perform a matching operation between the rule patterns and the first target data, or may perform a matching operation between the virus patterns and the second target data. Sometimes, the matching unit **350** may operate as a portion of the FW engine **340**, and may operate as a portion of the AV engine **360** at another time. An operational order may be appropriately determined by a predetermined scheduler.

When the first target data is received, the FW engine **340** determines whether to allow or block the first target data based on the rule pattern DB **320**. For example, the FW engine **340** determines whether data of the rule pattern DB **320** and the first target data are identical to each other. Then, when it is determined that the rule pattern DB **320** and the first target data are identical to each other, the FW engine **340** blocks or allows the first target data according to a predetermined rule.

When the second target data is received, the AV engine **360** may perform a scanning operation on the second target data by using the virus pattern DB **330**. According to an exemplary embodiment, the manager **310** may receive the second target data to be scanned, and the AV engine **360** may perform the scanning operation on the second target data received by the manager **310**.

FIG. **4** is a block diagram for explaining the FW engine **340**, the AV engine **360**, and the matching unit **350** of FIG. **3**, according to an exemplary embodiment.

Referring to FIG. **4**, the FW engine **340** and the AV engine **360** share the matching unit **350** with each other. In this case, the FW engine **340**, the AV engine **360**, and the matching unit **350** may be embodied in the form of SoC. The FW engine **340** may perform a filtering operation on target data such as a packet by using the rule pattern DB **320**, a first hash matcher table **370**, and a first sub matcher table **375**. The AV engine **360** may perform a scanning operation on target data such as a file by using the virus pattern DB **330**, a second hash matcher table **380**, and a second sub matcher table **385**.

When the FW engine **340** performs the filtering operation, the matching unit **350** may operate as a portion of the FW engine **340**. When the AW engine **360** performs the scanning operation, the matching unit **350** may operate as a portion of the AV engine **360**. The matching unit **350** may be configured as hardware. According to the present exemplary embodiment, the matching unit **350** may include a hash value matching unit **351** and a light pattern matching unit **352**.

The first hash matcher table **370** and the first sub matcher table **375** may be generated from rule patterns of the rule pattern DB **320**. The second hash matcher table **380** and the second sub matcher table **385** may be generated from virus patterns of the virus pattern DB **330**. A method of generating of the first hash matcher table **370**, the first sub matcher table **375**, the second hash matcher table **380**, and the second sub matcher table **385** will be described in detail with reference to FIGS. **5** through **7**.

The filtering operation of the FW engine **340** will now be described.

According to the present exemplary embodiment, the filtering operation by the FW engine **340** includes a packet classifying process and a rule pattern matching operation.

The packet classifying process includes at least one of an IP matching process, a protocol matching process, and a port matching process. These processes are performed by the hash value matching unit **351** and the light pattern matching unit **352**. In the packet classifying process, an exact pattern matching operation is not performed.

More specifically, in the IP matching process, the hash value matching unit **351** matches a hash value of an IP address included in the packet data and the first hash matcher table **370**. If the matching is successful, the light pattern matching unit **352** matches a middle value and a tail value of the IP address included in the packet data and the first sub matcher table **375**.

In the port matching process, the hash value matching unit **351** matches a hash value of a port included in the packet data and the first hash matcher table **370**. If the matching is successful, the light pattern matching unit **352** matches the hash value of the IP address and the hash value of the protocol included in the packet data and the first sub matcher table **375**.

In the protocol matching process, the hash value matching unit **351** matches a hash value of a protocol included in the packet data and the first hash matcher table **370**. In the protocol matching process in the present exemplary embodiment, the light pattern matching operation by the light pattern matching unit **352** is not performed and only the hash value matching operation is performed.

The above-described matching processes are performed by the hash matching unit **351** and the light pattern matching unit **352** in sequence. The IP matching process, the port matching process, and the protocol matching process will be described in detail below with reference to FIGS. **21** to **24**.

If the packet classifying process for the packet data is completed, the FW engine **340** performs a rule pattern matching operation. The rule pattern matching operation is not performed for all of the packet data and is performed for only the packet data which has been classified as data to be rule pattern-matched. The packet classifying process will be explained in detail below with reference to FIG. **21**.

The rule pattern matching operation is performed by the hash value matching unit **351** and the light pattern matching unit **352**. If the light pattern matching is successful, the exact pattern matching is performed. The light pattern matching and the exact pattern matching will now explained.

When performing the rule pattern matching operation, the hash value matching unit **351** matches the hash value of the IP address included in the packet data and the first hash matcher table **370**. If the hash value matching is successful, the light pattern matching unit **352** matches the middle value and the tail value of the IP address included in the packet data and the second sub matcher table **375**. If the light pattern matching is successful, the FW engine **340** matches header information (such as a source IP address, a destination IP address, a protocol, a source port, a destination port, an input/output direction, and the like) of the packet data and a real rule pattern.

As described above, the hash value matching unit **351** and the light pattern matching unit **352** may perform the packet classifying process and the rule pattern matching operation in sequence. The first hash matcher table **370** and the first sub matcher table **375** may be commonly used in the packet classifying process and the rule pattern matching operation. However, a hash matcher table and a sub matcher table for use in the packet classifying process and a hash matcher table and a sub matcher table for use in the rule pattern matching operation may be separately provided.

According to the present exemplary embodiment, the rule pattern DB **320** may include at least one of a source IP address, a destination IP address, a protocol, a source port, a destination port, a transmission control protocol (TCP) flag, and an input/output direction of a packet. In this case, the input/output direction of a packet indicates whether the first target data is transmitted outwards, or is received from an external source through a NIC.

According to an exemplary embodiment, the FW engine **340** may generate the first hash matcher table **370** and the first sub matcher table **375** with reference to the rule pattern DB **320**, as shown in FIG. **5**. According to the present exemplary embodiment, the first hash matcher table **370** and the first sub matcher table **375** are generated by the FW engine **340**, but this is merely an example. A separate component may generate the first hash matcher table **370** and the first sub matcher table **375**, or alternatively, another component (e.g., the manager **310**) may generate the first hash matcher table **370** and the first sub matcher table **375**.

FIG. **5** shows the first hash matcher table **370** and the first sub matcher table **375** of FIG. **4**, according to an exemplary embodiment.

Referring to FIG. **5**, (a) shows an example of header information, (b) shows an example of a hash matcher table, and (c) shows an example of a sub-matcher table.

In the present exemplary embodiment, the firewall engine may generate a hash matcher table using the rule pattern stored in the rule pattern DB. More specifically, the firewall engine obtains all hash values for IP addresses included in the rule patterns by using a hash function and configures the hash matcher table of (b) of FIG. **5** based on the hash values.

Referring to (b) of FIG. **5**, the hash matcher table includes an index item and a presence/absence item indicating whether an index exists or not. The index is determined by all hash values that can be obtained by the predetermined hash function, and, if an index value is the same as the hash value of the IP address of the rule pattern, the index is set to "1" in the presence/absence item.

The hash matcher table further includes a hash value for the protocol and a hash value for the port.

The firewall engine may generate the sub matcher table. The firewall engine newly generates a sub matcher table and a hash matcher table every time that the rule pattern DB is updated. The firewall engine may generate the sub matcher table from the rule pattern DB and/or the hash matcher table.

The sub matcher table includes an index item, a mid item, a tail item, an ispro item, an isport item, a real pattern memory address item, and a next item.

The sub matcher table will be explained with reference to (c) of FIG. **5** for convenience of understanding. According to the first record of (c) of FIG. **5**, the index item is 'X', the mid item is '0x03', the tail item is '0x21', the ispro item is '1', the isport item is '1', the real pattern memory address item is '0x0001', and the next item is 'R'.

The values shown in the index item of the sub matcher table are values having a value '1' in the presence/absence item of the hash matcher table. In other words, the index 'X' of the first record of the sub matcher table also exists in the hash matcher table and has a value of '1' in the presence/absence item. On the other hand, the value 'R' does not exist in the hash matcher table but exists in the sub matcher table as an index value. This value is provided in case that rule patterns are different but hash values of IP address are the same, in other words, in case that a hash collision occurs. For example, a rule pattern A and a rule pattern B have different IP addresses, but a hash value of the IP address of the rule pattern A and a hash value of the IP address of the rule pattern B are the same (for example, a hash value of 'X') (i.e., hash collision). In this case, as shown in the sub matcher table of (c) of FIG. **5**, the hash value of the IP address of the rule pattern A is written as 'X' and the hash value of the IP address of the rule pattern B is written as 'R', and 'R' is written in the next item. If sub matching is not successful as a result of performing sub-matching with respect to the record of the index 'X', the sub matching for the record of the index 'R' is performed again. According to an exemplary embodiment, the 'R' written in the next item may be defined as a difference between a memory address in which the record of the index 'X' is stored and a memory address in which the record of the index 'R' is stored.

The values written in the index item of the sub matcher table (for example, X, A, or B) may be obtained from the hash

matcher table or may be obtained directly from the rule pattern DB without using the hash matcher table. In other words, the hash values for the IP addresses owned by the rule patterns of the rule pattern DB may be written as indexes in the sub matcher table.

The index 'X' of the first record of the sub matcher table is a hash value for an IP address of a rule pattern stored in a memory address ('0x0001') designated by the real pattern memory address item.

The value '0x03' in the mid item of the sub matcher table is a value of a middle byte of the IP address of the rule pattern stored in the memory address ('0x0001') designated by the real pattern memory address item.

The value '0x21' in the tail item of the sub matcher table is a value of a tail byte of the IP address of the rule pattern stored in the memory address ('0x0001') designated by the real pattern memory address item.

The value '1' in the ispro item of the sub matcher table means that the rule pattern stored in the memory address ('0x0001') designated by the real pattern memory address item is applied to all protocols.

The value '1' in the isport item of the sub matcher table means that the rule pattern stored in the memory address ('0x0001') designated by the real pattern memory address item is applied to all ports.

The above explanation has been made for an IP matching process and is about the area marked 'IP sub' in the sub matcher table of (c) of FIG. **5**. Hereinafter, the area marked 'Port sub' in the sub matcher table of (c) of FIG. **5** will be explained. Values in this area are used for a port matching process.

An index 'A' in the sub matcher table of (c) of FIG. **5** means that a hash value of a port of a rule pattern stored in a memory address ('0x2000') designated by the real pattern memory address item is applied to all ports. A value 'C' in an IP hash item is a hash value of an IP address included in the rule pattern stored in the memory address ('0x2000') designated b the real pattern memory address item. A value 'D' in a proto hash item is a hash value of a port included in the rule pattern stored in the memory address ('0x2000') designated by the real pattern memory address. An index 'B' is provided in case that IP hash values collide.

The above-described hash matcher table and the sub matcher table may be generated by the firewall engine and may also be generated by a separately provided element other than the firewall engine.

Hereinafter, the scanning operation of the AV engine **360** will be described.

The AV engine **360** may perform the scanning operation by using the virus pattern DB **330** in order to determine whether the second target data received by the manager **310** contains virus. According to an exemplary embodiment, the scanning operation of the AV engine **360** and the filtering operation of the FW engine **340** may be alternately performed. Alternatively, any of the AV engine **360** and the FW engine **340** may have priority over operations. The priority may be determined according to the default or user's settings.

According to an exemplary embodiment, the AV engine **360** may perform a matching operation between sub data of the second target data and virus patterns. The AV engine **360** may be embodied as at least one of hardware and software.

The AV engine **360** may generate a hash value for virus patterns of the virus pattern DB **330**. Hereinafter, a data of the virus patterns will be referred to as the virus "pattern data". The AV engine **360** may generate the hash value for the virus patterns by applying a hash function to virus pattern data. For example, it is assumed that virus pattern data is 23 bytes long. In this case, the AV engine **360** may calculate a hash value by applying virus pattern data from a first byte to a third byte to the hash function, may calculate a hash value by applying virus pattern data from a second byte to a fourth byte to the hash function, and likewise may calculate all hash values for data of 23 bytes so as to generate the second hash matcher table **380** and the second sub matcher table **385**. Thus, depending one the cases, the same hash value may be generated for different virus patterns. According to the present exemplary embodiment, the AV engine **360** generates the second hash matcher table **380** and the second sub matcher table **385**, but this is merely an example. Alternatively, a separate component may generate the second hash matcher table **380** and the second sub matcher table **385**, or another component (e.g., the manager **310**) may generate the second hash matcher table **380** and the second sub matcher table **385**.

FIG. **6** shows an example of a pattern hash value table used in the AV engine **360**, according to an exemplary embodiment. Referring to FIG. **6**, in the pattern hash value table, virus patterns correspond to hash values obtained from the virus patterns, respectively. For example, a virus pattern having a hash value 'X' is 'abcdefg'.

The AV engine **360** may generate a hash value for the second target data. For example, if it is assumed that the second target data includes sub data S**1**, S**2**, S**3**, . . . that are divided to each have a predefined size, the AV engine **360** may respectively generate a hash values H_S from the sub data S**1**, S**2**, S**3**, ... According to an exemplary embodiment, the AV engine **360** generates a hash value by applying a portion of sub data to the hash function. For example, it is assumed that the sub data is 15 bytes long. In this case, the AV engine **360** may generate a hash value by applying values from a first byte to a third byte of the sub data to the hash function, may generate a hash value by applying values from a second byte to a fourth type of the sub data to the hash function, may generate a hash value by applying values from a third byte to a fifth byte of the sub data to the hash function, and likewise may generate hash values for the remaining bytes.

According to an exemplary embodiment, the second hash matcher table **380** may be used in the hash value matching unit **351**. The second sub matcher table **385** may be used in the light pattern matching unit **352**, and may be used during the exact matching operation.

The hash value matching unit **351** matches a hash value H_{T1} for at least a portion of the second target data with the second hash matcher table **380**. When the second target data is divided into the sub data, the hash value matching unit **351** matches a hash value for a portion of each sub data with the second hash matcher table **380**. Hereinafter an example of the sub data will be described.

Referring to FIG. **7**, in the second hash matcher table **380**, matching indexes in which '1' is selected are each any one of hash values H_P of virus patterns.

In the second hash matcher table **380**, if there are matching indexes (e.g., X and Y) in which '1' is selected, and matching indexes identical to a hash value H_S of the sub data, it may be determined that the hash-value matching is successful. In FIG. **7**, when the hash value H_S of the sub data is 'X' or 'Y', it may be determined that the hash-value matching is successful.

When the hash-value matching is successful, the light pattern matching unit **352** performs LPM by using the sub data on which the hash-value matching is successful, and the second hash matcher table **380**. In detail, the light pattern matching unit **352** may match a virus pattern corresponding to a matching index (e.g., X) identical to the hash value H_S with a pattern of sub data.

LPM is an operation of matching a middle value and a tail value of a virus pattern having a hash value H_{P1} which the hash-value matching is successful with a middle value and a tail value of sub data. According to an exemplary embodiment, the light pattern matching unit **352** matches the middle value and the tail value of the sub data with the second sub matcher table **385**. When LPM fails, that is, when middle values are not identical to each other, or tail values are not identical to each other, it means that there is no virus pattern in the sub data. Thus, the sub data may be determined to be normal data.

On the other hand, when LPM is successful, the AV engine **360** may perform EPM by using a virus pattern, sub data, and the second sub matcher table **385**. EPM is an operation of comparing all positions of a virus pattern having the hash value H_{P1} with all positions of sub data and matching patterns. In detail, the AV engine **360** identifies an address of a virus pattern that is mapping-stored in a matching index X, with reference to the second sub matcher table **385**. The AV engine **360** reads the virus pattern stored in the identified address from the virus pattern DB **330**. The AV engine **360** matches 'abcdefg' that is a whole pattern of a virus pattern stored in a corresponding address with a whole pattern of the second target data.

When EPM is successful, that is, when values of all positions are identical to each other, the AV engine **360** may determine that virus exists in target data. Although EPM is successful as a result of scanning performed on any sub data, if the sub data is a portion of a grammatically complex virus pattern, the AV engine **360** may perform FPM. For example, when the sub data on which EPM is successful is identical to a portion of a grammatically complex virus pattern, the AV engine **360** may perform a matching operation on the remaining sub data. The AV engine **360** may determine whether the sub data is identical to the grammatically complex virus pattern by comparing a matching result of sub data and the virus pattern.

According to an exemplary embodiment, the EPM results of the sub data are recorded in a sub pattern matrix. The AV engine **360** may determine whether virus exists in target data, with reference to the sub pattern matrix. An operation of determining whether virus exists in target data with reference to the sub pattern matrix corresponds to an example of a full matching operation.

As a result of FPM, when the FPM is successful, the AV engine **360** may determine that the second target is normal data. On the other hand, as a result of FPM, when FPM is not successful, the AV engine **360** may determine that the second target data is virus-infected, and may notify the manager **310** about the determination result.

According to the above-described exemplary embodiment, the AV engine **360** receives target data to be scanned from the manager **310**, but the FW engine **340** directly receives packet data without the manager **310**, and performs filtering on the packet data. The FW engine **340** may notify the manager **310** about the filtering result. In addition, the manager **310** may notify a FW interface application about the filtering result.

The reasons of separating a task of the manager **310** and a task of the FW engine **340** will now be described.

First, a situation in which the manager **310** controls the FW engine **340** occurs less frequency than a situation in which the FW engine **340** filters the first target data. Thus, it is efficient to separate the task of the manager **310** and the task of the FW engine **340**.

Second, the FW engine **340** needs to swiftly determine whether first target data is malicious data for every first target data and to determine whether the first target data is to be transmitted. When a user changes a FW rule, if the FW engine **340** directly changes the rule pattern DB **320**, that is, if the FW engine **340**, instead of the manager **310** changes the rule pattern DB **320**, a processing operation on the first target data, which is performed by the FW engine **340**, is delayed. Thus, in order to overcome this problem and to prioritize the tasks of the manager **310** and the FW engine **340**, the manager **310** and the FW engine **340** may be configured as separate modules.

FIG. **8** is a functional block diagram for explaining an operation of a second anti-malware system **800**, according to another exemplary embodiment.

Referring to FIG. **8**, the second anti-malware system **800** may include a manager **810**, a rule pattern DB **820**, a virus pattern DB **830**, a FW engine **840**, a matching unit **850**, an AV engine **860**, and a communication unit **870**.

Operations of the manager **810**, the rule pattern DB **820**, the virus pattern DB **830**, the FW engine **840**, the matching unit **850** and the AV engine **860** of FIG. **8** are the same as or similar to operations of the manager **310**, the rule pattern DB **320**, the virus pattern DB **330**, the FW engine **340**, the matching unit **350**, and the AV engine **360** described with reference to FIGS. **3** and **4**, and thus their detailed descriptions will be omitted herein. In addition, the FW engine **840** and the AV engine **860** may share the matching unit **850**, and the matching unit **850** may be embodied based on hardware logic.

The second anti-malware system **800** may further include the communication unit **870**. A combination of the manager **810**, the rule pattern DB **820**, the virus pattern DB **830**, the FW engine **840**, the matching unit **850**, the AV engine **860**, and the communication unit **870** may be embodied as a single SoC.

The communication unit **870** may receive first target data from an external device, transmit the first target data to an external device and may include at least one of a wireless fidelity (WiFi) module, a local area network (LAN) module, an over the air (OTA) module, a Bluetooth module, and a 4G module, as a communication module. The first target data received through the communication unit **870** is input to the FW engine **840**. The FW engine **840** generates a hash value for the received first target data, and may perform hash-value matching, LPM and EPM, as described with reference to FIG. **3**. As a result of the EPM, when it is determined that the first target data is normal data, the FW engine **840** may transmit the first target data to an application unit (not shown).

FIG. **9** is a functional block diagram for explaining an operation of a third anti-malware system **900**, according to another exemplary embodiment.

Referring to FIG. **9**, the third anti-malware system **900** may include an anti-malware (AM) manager **905**, a FW manager **910**, a rule pattern DB **920**, a FW engine **930**, an AV manager **940**, a virus pattern DB **950**, and an AV engine **960**.

Operations of the AM manager **905**, the FW manager **910**, the rule pattern DB **920**, the FW engine **930**, the AV manager **940**, the virus pattern DB **950** and the AV engine **960** of FIG. **9** are the same as or similar to operations of the manager **310**, the rule pattern DB **320**, the virus pattern DB **330**, the FW engine **340**, the matching unit **350**, and the AV engine **360** described with reference to FIG. **3**, and thus their detailed description will be omitted herein.

However, in FIG. **9**, the manager **310** of FIG. **3** is substituted with three managers (i.e., the AM manager **905**, the AV manager **940**, and the FW manager **910**). In FIG. **3**, the manager **310** performs all operations of the AM manager **905**, the AV manager **940**, and the FW manager **910**. However, in FIG. **9**, the three managers (i.e., the AM manager **905**, the AV manager **940**, and the FW manager **910**) perform respective

separate operations. To configure a single manager or three managers is merely an example, and thus another method (e.g., a method of increasing the number of manages and subdividing an operation) may also be used.

Referring to FIG. **9**, the AM manager **905** may interwork with a FW UI application and an AV UI application. The AM manager **905** receives a command from the FW UI application and the AV UI application. When the command is related to FW, the AM manager **905** transmits the command to the FW manager **910**. When the command is related to AV, the AM manager **905** transmits the command to the AV manager **940**. The FW manager **910** and the AV manager **940** perform an operation corresponding to the command, and then may transmit the result to the AM manager **905**. The AM manager **905** transmits each application the result transmitted from the FW manager **910** and the AV manager **940**.

The command received from the FW UI application by the AM manager **905** may be, for example, a command for updating the rule pattern DB **920**. In the presence of the command for updating the rule pattern DB **920**, the AM manager **905** transmits the command for updating (generating/deleting/adding/changing) the rule pattern DB **920** to the FW manager **910**. The FW manager **910** may update the rule pattern DB **920**, and may notify the AM manager **905** about the updating result.

The command received from the AV UI application (not shown) by the AM manager **905** may be, for example, a scanning command or a command for updating the virus pattern DB **950**. In the presence of the scanning command, the AM manager **905** notifies the AV manager **940** about the scanning command, and notifies the AV engine **960** about the scanning command. The AV engine **960** may perform a scanning operation on target data (e.g., the target data together with the scanning command may be received by the AM manager **905**). The performing result is reversely transmitted to the AV UI application through the AV manager **940** and the AM manager **905**.

The command received from the AV UI application (not shown) by the AM manager **905** may be a command for updating the virus pattern DB **950**. In this case, the AV manager **940** may perform an updating operation corresponding to the command.

FIG. **10** is a block diagram for explaining the FW engine **930**, according to an exemplary embodiment.

Referring to FIG. **10**, the FW engine **930** includes a first matching unit **931**. The first matching unit **931** performs a similar operation as the matching unit **350** of FIG. **4**, and thus will be understood with reference to FIG. **4**. A detailed description of the first matching unit **931** will be omitted herein.

A first hash matcher table **970** and a first sub matcher table **975** may be generated from rule patterns of the rule pattern DB **920**, which will be understood with reference to FIGS. **4** and **5**.

FIG. **11** is a block diagram for explaining the AV engine **960**, according to an exemplary embodiment.

Referring to FIG. **11**, the AV engine **960** includes a second matching unit **961**. The second matching unit **961** performs a similar operation as the matching unit **350** of FIG. **4**, and thus will be understood with reference to FIG. **4**. A detailed description of the second matching unit **961** will be omitted herein.

A second hash matcher table **980** and a second sub matcher table **985** may be generated from virus patterns of the virus pattern DB **950**. A method of generating the second hash matcher table **980** and the second sub matcher table **985** will be understood with reference to FIGS. **4**, **6**, and **7**, and thus its detailed description will be omitted herein.

The AV engine **960** may generate hash values of virus patterns of the virus pattern DB **950** and a hash value for at least a portion of the second target data.

The second matching unit **961** may perform hash-value matching and LPM by using the second hash matcher table **980** and the second sub matcher table **985**. The second matching unit **961** includes a second hash value matching unit **961***a* and a second light pattern matching unit **961***b*.

The second hash value matching unit **961***a* may match the hash values of the virus patterns generated from the AV engine **960** with the hash value for at least a portion of the second target data.

When the hash-value matching is successful in the second hash value matching unit **961***a*, the second light pattern matching unit **961***b* performs LPM.

When the LPM is successful, the AV engine **960** may perform the EPM by using a virus pattern, the second target data, and the second sub matcher table **985**.

When the EPM is successful, the AV engine **960** performs FPM by using a sub pattern matrix.

As a result of FPM, when the FPM is successful, the AV engine **960** determines that the second target data is normal data, and transmits the second target data to a nest destination. On the other hand, as a result of FPM, when the FPM is not successful, the AV engine **960** determines that the second target data is virus-infected. According to the present exemplary embodiment, a pattern DB stores a black list. In addition, the pattern DB may store a white list. When the white list is stored, as results of EPM or FPM, when the pattern matching is successful, the second target data may be determined to be normal data. The pattern matching includes the hash-value matching, the LPM, the EPM or the FPM.

FIG. **12** is a functional block diagram for explaining an operation of a fourth anti-malware system **1200** according to another exemplary embodiment.

Referring to FIG. **12**, the fourth anti-malware system **1200** may include a FW manager **1210**, a rule pattern DB **1220**, a FW engine **1230**, an AV manager **1240**, a virus pattern DB **1250**, an AV engine **1260**, and a communication unit **1270**. The fourth anti-malware system **1200** of FIG. **12** may further include the AM manager **905** of FIG. **9**. The FW manager **1210**, the rule pattern DB **1220**, the FW engine **1230**, the AV manager **1240**, the virus pattern DB **1250**, and the AV engine **1260** of FIG. **11** are the same as or similar to the FW manager **910**, the rule pattern DB **920**, the FW engine **930**, the AV manager **940**, the virus pattern DB **950**, and the AV engine **960** described with reference to FIGS. **9** through **11**, and thus their detailed descriptions will be omitted herein.

However, the fourth anti-malware system **1200** further includes the communication unit **1270**. The communication unit **1270** is a communication module that receives the first target data from an external device, and transmits the first target data to the external device. A combination of the FW manager **1210**, the rule pattern DB **1220**, the FW engine **1230**, the AV manager **1240**, the virus pattern DB **1250**, the AV engine **1260**, and the communication unit **1270** may be embodied as a single SoC.

The first target data received through the communication unit **1270** is input to the FW engine **1230**. The FW engine **1230** may generate a hash value for the received first target data, and may perform hash-value matching, LPM and EPM described with reference to FIG. **3**. As a result of the EPM, when the first target data is determined to be normal data, the FW engine **1230** may transmit the first target data to an

application unit (not shown). The application unit (not shown) may be, for example, a web browser.

FIG. **13** is a flowchart of an operating method of an anti-malware system, according to an exemplary embodiment.

The operating method of FIG. **13** may be performed by any one of the first through fourth anti-malware systems **300**, **800**, **900**, and **1200**. Hereinafter, the operating method will be described in terms of the first anti-malware system **100**.

The manager **310** may update and store the rule pattern DB **320** including rule patterns and the virus pattern DB **330** including virus patterns (operation S**1302**). The manager **310** may generate the rule pattern DB **320** by using a default rule pattern or rule patterns that are set by a user through a FW UI.

The FW engine **340** generates and stores the first hash matcher table ('first HMT') **370** and the first sub matcher table ('first SMT') **375** by using hash values of rule patterns, and the AV engine **360** may generate and store the second hash matcher table ('second HMT') **380** and the second sub matcher table ('second SMT') **385** by using hash value for virus patterns (operation S**1304**).

When the FW engine **340** receives target data (operation S**1306**), the FW engine **340** may generate a hash value for at least a portion of the received target data (hereinafter, referred to as 'first target data') by applying the first target data to the hash function (operation S**1308**).

The hash value matching unit **351** of the matching unit **350** may match hash values of the rule patterns generated in Operation S**1302** with a hash value for at least a portion of the first target data generated in Operation S**1308** (operation S**1310**).

When hash-matching is successful (operation S**1312**-Y), the light pattern matching unit **352** may perform LPM by using a rule pattern, the first target data, and the first hash matcher table **370** (operation S**1314**).

When the LPM of Operation S**1314** is successful (operation S**1316**-Y), the FW engine **340** may perform EPM by using the rule pattern, the first target data, and the first sub matcher table **375** (operation S**1318**).

When the EPM of Operation S**1318** is successful (operation S**1320**-Y), the FW engine **340** may determine that the first target data is normal data, and may block the first target data (operation S**1322**).

On the other hand, when there are no hash values that are matched with each other in Operation S**1312** (operation S**1312**-N), the FW engine **340** may determine that the first target data is normal data, and may allow the first target data (operation S**1324**).

When the LPM of Operation S**1314** fails (operation S**1316**-N), the FW engine **340** may determine that the first target data is normal data (operation S**1324**).

When the EPM of Operation S**1318** fails (operation S**1320**-N), the FW engine **340** may determine that the first target data is abnormal data (operation S**1324**).

When the manager **310** receives target data, since the target data is to be virus-scanned, the manager **310** may transmit the received target data to the AV engine **360** (operation S**1326**).

The AV engine **360** may generate a hash value for the received target data (hereinafter, referred to as 'second target data') by applying the second target data to the hash function (operation S**1328**). In Operation S**1328**, the AV engine **360** may generate a hash value for each sub data obtained by dividing the second target data to have a predetermined size.

The hash value matching unit **351** of the matching unit **350** may match hash values of the virus patterns generated in Operation S**1302** with a hash value for at least a portion of the second target data generated in Operation S**1328** (operation S**1330**).

When hash-value matching is successful (operation S**1332**-Y), the light pattern matching unit **352** may perform LPM by using a virus pattern, second target data, and the second hash matcher table **380** (operation S**1334**).

When the LPM of Operation S**1334** is successful (operation S**1336**-Y), the AV engine **360** may perform EPM by using a virus pattern, second target data, and the second sub matcher table **385** (operation S**1338**).

When the EPM of Operation S**1338** is successful (operation S**1340**-Y), the AV engine **360** may perform FPM (operation S**1342**).

When the FPM of Operation S**1342** is successful (operation S**1344**-Y), the AV engine **360** may determine that the second target data is virus-infected data, and may block the second target data (operation S**1322**). Thus, the AV engine **360** may not transmit the second target data to be virus-scanned to an external device or an application unit (not shown) using the second target data.

On the other hand, when there are no hash values that are matched with each other in Operation S**1332** (operation S**1332**-N), the AV engine **360** may determine that the second target data is normal data, and may allow the second target data (operation S**1324**). Thus, the AV engine **360** may transmit the second target data to be virus-scanned to an external device or an application unit (not shown) using the second target data.

When the LPM of Operation S**1334** fails (operation S**1336**-N), the AV engine **360** may determine that the second target data is normal data (operation S**1324**).

When the EPM of Operation S**1338** fails (operation S**1340**-N), the AV engine **360** may determine that the second target data is normal data (operation S**1324**).

When the FPM of Operation S**1342** fails (operation S**1344**-N), the AV engine **360** may determine that the second target data is normal data, may allow the second target data, and may transmit the second target data to a next destination (operation S**1324**).

It should be understood that, in the exemplary embodiment described above with reference to FIG. **13**, the packet classifying process has not been mentioned and only the rule pattern matching operation has been explained for convenience of understanding. In other words, operations S**1308** to **1324** relate to the rule pattern matching operation and the packet classifying operation may be performed between operations S**1308** and S**1306**.

FIG. **14** is a block diagram of a hardware configuration of the anti-virus H/W **117** of FIG. **2**, according to an exemplary embodiment.

Referring to FIG. **14**, the anti-virus H/W according to an exemplary embodiment includes a system interface **201**, a system register **203**, a memory interface **205**, a memory **207**, a buffer **209**, a hash matcher **211**, an offset address generator **213**, a hash queue (Q) buffer **215**, a light pattern matcher **217**, and a scan Q buffer **219**. According to an exemplary embodiment, the matching unit of FIG. **14** may be used as the matching unit of FIG. **3**, **4**, **8**, or **9**.

The system interface **201** supports an interface between the anti-malware system **100** and an external device, and the memory interface **205** is used to read out a DB or a file stored in the anti-malware system.

The memory **207** may store data (for example, a pattern hash value table) that is used by the hash matcher **211** to perform a hash matching operation.

The buffer **209** may store target data read out by the memory interface **205**. In the present exemplary embodiment, the buffer **209** may be configured in a dual bank form. The target data is divided into sub-data as much as the buffer **209**

can store and the sub-data is stored in the two buffers **209**. If the matching unit of FIG. **14** is used as a part of the anti-virus engine, the target data may be data such as a file. On the other hand, if the matching unit of FIG. **14** is used as a part of the firewall engine, the target data may be packet data.

The hash matcher **211** matches a hash value of the target data and a hash matcher table **43**. The hash matcher **211** stores target data a hash value of which has been successfully matched in the hash Q buffer **215**.

If the hash value matching is successful, the offset address generator **213** generates a memory address in which the hash value matched in the sub matcher table is stored.

The hash Q buffer **215** makes the address generated by the offset address generator **213** correspond to the target data and stores them.

The light pattern matcher **217** matches a part of the target data stored in the hash Q buffer **215** (for example, the middle value and the tail value of the target data) and a virus pattern (or an IP hash value of a rule pattern, a protocol hash value, or a middle value of an IP address) with each other. The light pattern matcher **217** stores the target data which has been successfully matched by the light pattern matching operation in the scan Q buffer **219**.

The scan Q buffer **219** may store the target data which has been successfully matched by the light pattern matching operation.

If the anti-virus H/W of FIG. **14** is used as a part of the anti-virus engine, the anti-virus engine may perform an exact matching operation to match the target data stored in the scan Q buffer **219** and the virus pattern exactly, and performs a full pattern matching operation if the exact matching operation is successful. The full pattern matching operation is performed if the data has a grammatically complex pattern. In the case of data of a grammatically simple pattern, only the exact pattern matching operation is further performed.

On the other hand, if the anti-virus H/W of FIG. **14** is used as a part of the firewall engine, the firewall engine may perform an exact matching operation to match the target data stored in the scan Q buffer **219** and the rule pattern exactly.

Of the above-described matching operations, the virus pattern matching operation may be as described in detail in Korean Patent Application No. 10-2010-0049566 (filed on May 27, 2010), Korean Patent Application No. 10-2010-0052981 (filed on Jun. 4, 2010), and Korean Patent Application No. 10-2011-0049249 (filed on May 24, 2011). These documents are hereby incorporated by reference to the same extent unless otherwise indicated herein or otherwise clearly contradicted by context.

FIG. **15** is a block diagram for explaining a virus scanning operation in the anti-virus H/W **117**, according to an exemplary embodiment.

Referring to FIG. **15**, virus patterns to be used in the virus scanning operation are stored in a virus pattern DB **41**. A virus pattern DB **41** may be one of the virus pattern DBs **330**, **830**, **950**, and **1250** shown in FIGS. **3** through **12**.

The hash matcher table **43** transmits and receives data to and from the hash matcher **211**, and is used to perform hash matching in the hash matcher **211**. The hash matcher table **43** may be one of the hash matcher tables **380** and **980** shown in FIGS. **4** and **11**.

When all virus patterns stored in the virus pattern DB **41** are loaded into the memory **207**, and then a hash value generator (not shown) generates hash values for the all virus patterns loaded into the memory **207**, a pattern hash value table is generated from the generated hash values. The pattern hash value table may be stored in the memory **207**.

The sub matcher table **44** transmits and receives data to and from the light pattern matcher **217**, and is used to perform LPM and EPM. According to an exemplary embodiment, the sub matcher table **44** may contain a duplicate pattern offset, a middle value offset, a middle value, a tail value offset, a tail value, and real pattern information. The sub matcher table **44** may be one of the sub matcher tables **375** and **975** shown in FIGS. **4** and **10**.

A sub pattern matrix **45** may include a sub pattern matching result for each sub data constituting target data. The sub pattern matrix **45** is used to perform FPM. When it is determined whether a virus pattern exists in corresponding sub data, as a result of the EPM for all virus patterns and all sub data, whether the virus pattern exists for respective sub data is recorded in the sub pattern matrix **45**.

The sub data of target data is loaded into the buffer **209**, and the loaded sub data is provided to the hash matcher **211**.

To this end, the hash matcher **211** receives a pattern hash value table **42**, sub data, and the hash matcher table **43** from the memory **207**, the buffer **209**, and a memory (not shown) (e.g., the SRAM **130** of FIG. **2**), respectively, and performs hash matching.

The hash Q buffer **215** may store the target data when hash values are matched with each other by the hash matcher **211**.

Then, the light pattern matcher **217** may perform a matching operation on a portion of the sub data by using the sub matcher table **44**. When light pattern matching is successful, the light pattern matcher **217** outputs the sub data on which the light pattern matching is successful towards the scan Q buffer **219**. An output result from the scan Q buffer **219** is used to perform the EPM.

When the EPM is successful, an anti-malware system performs full matching between sub data and a virus pattern, included in a sub pattern matrix, by using the sub pattern matrix **45**. That is, matching between the virus pattern and whole target data is performed on the target data stored in the scan Q buffer **219**.

FIG. **16** is a flowchart of an operating method of the anti-virus H/W **117** in an anti-malware system, according to an exemplary embodiment.

Referring to FIG. **16**, when the anti-virus H/W **117** is initialized (operation **S1601**), the virus pattern DB **41** in which virus patterns are stored is loaded into the memory **207** (operation **S1603**).

Target data (e.g., the second target data of FIG. **3**) to be virus-scanned is loaded into the buffer **209** by the size of the buffer **209** (operation **S1605**).

The hash matcher **211** reads target data and a pattern hash value table from the buffer **209** and the memory **207**, respectively, by predetermined sizes (operation **S1607**). The pattern hash value table of the target data may be previously generated, and may be stored in the memory **207**.

The hash matcher **211** matches hash valued of the target data and the virus patterns, which are read in Operation **S1607**, with each other (operation **S1609**).

The size of the read target data is set according to target data count (operation **S1611**).

When the target data count is compared with the size of the buffer **209**, and the target data is identical to the size of the buffer **209** (operation **S1613**-Y), the anti-virus H/W **117** changes a buffer that is currently used to another buffer (operation **S1615**). When the buffer is changed, target data is loaded into the changed buffer, and Operations **S1605** through **S1613** are repeated.

When the target data count is not identical to the size of the buffer **209** (operation **S1615**-N), the anti-virus H/W **117** determines that the hash Q buffer **215** is full or not (operation

S1617). When the hash Q buffer **215** is full, the anti-virus H/W **117** finishes a corresponding operation. When the hash Q buffer **215** is not full, Operations S**1607** through S**1615** are repeated until the hash Q buffer **215** is full.

FIG. **17** is a flowchart of the matching operation of the hash matcher **211** of Operation S**1609** of FIG. **16**, according to an exemplary embodiment.

Referring to FIG. **17**, the hash matcher **211** determines whether a hash value for the target data exists in a pattern hash value table (operation S**1701**).

When the hash value for the target data exists in the hash matcher table, the hash matcher **211** determines whether pattern indication exists in the hash value for the target data (operation S**1703**).

When the hash indication exists in the hash value for the target data, the hash matcher **211** determines whether the hash Q buffer **215** is full (operation S**1705**).

When the hash Q buffer **215** is not full (operation S**1705**-N), the hash matcher **211** updates the hash Q buffer **215** by using the latest information (operation S**1707**). The latest information is data generated by the offset address generator **213**, and may include a memory address value for a real comparison memory region corresponding to a hash value when matching is successful, as a result of a matching operation of the hash matcher **211**.

Then, when a reading operation is performed by the hash Q buffer **215** (operation S**1709**-Y), the light pattern matcher **217** performs LPM (operation S**1711**).

On the other hand, when the hash Q buffer **215** is full (operation S**1705**-Y), the hash matcher **211** sets the hash Q buffer **215** to be full (operation S**1713**).

FIG. **18** is a flowchart for explaining the matching operation of the light pattern matcher **217** of Operation S**1711**, according to an exemplary embodiment.

Referring to FIG. **18**, the light pattern matcher **217** reads a pattern from a memory determined by an offset of a hash value for the read target data (operation S**1801**). That is, the light pattern matcher **217** may read a middle value and a tail value of a pattern of target data corresponding to a hash value, and may read a middle value and a tail value of a virus pattern from the sub matcher table **44**.

The light pattern matcher **217** determines whether the middle value of the target data is identical to the middle value of the virus pattern (operation S**1803**).

When the middle value of the target data is identical to the middle value of the virus pattern (operation S**1803**-Y), the light pattern matcher **217** determines whether the tail value of the target data is identical to the tail value of the virus pattern (operation S**1805**).

When the tail value of the target data is identical to the tail value of the virus pattern (operation S**1805**-Y), the light pattern matcher **217** determines whether the scan Q buffer **219** is full (operation S**1807**).

When the scan Q buffer **219** is not full (operation S**1807**-N), the light pattern matcher **217** updates the scan Q buffer **219** by using the latest information (operation S**1809**). The latest information may be a result of a matching operation of the light pattern matcher **217**, used to perform FPM.

When the scan Q buffer **219** is full (operation S**1807**-Y), the light pattern matcher **217** sets the scan Q buffer **219** to be full (operation S**1811**).

FIG. **19** is a block diagram for explaining a packet filtering operation performed in the firewall H/W **119**, according to an exemplary embodiment.

Referring to FIG. **19**, the firewall engine matches packet data and a rule pattern using the matching unit **119** configured by hardware. In the present exemplary embodiment, the firewall engine matches information included in a header of the packet data such as IP address, protocol, or port and the rule pattern.

Referring to FIG. **19**, the rule pattern DB **51** may store at least one packet rule and may include a direction of a packet, an IP address, a protocol, a port, permission/block information. The direction of the packet indicates a direction in which the packet is forwarded and is denoted by 'In', 'Out', and 'Both', and the IP address indicates a source IP address and a destination IP address, the IP address protocol indicates a type of a protocol used, such as Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Internet Control Message Protocol (ICMP), and All, and the port indicates a port number to be set, and the permission/block information indicates whether to permit or block the packet.

In the present exemplary embodiment, the hash matcher **211** performs a hash value matching operation using the hash matcher table **53**, and the light pattern matcher **217** performs a light pattern matching operation using the sub matcher table **54**. The hash matcher **211** matches a hash value of data stored in the buffer **209** and the hash matcher table **53** in a hardware level. The data the hash value of which has been matched is stored in the hash Q buffer **215**, and the light pattern matcher **217** matches the data stored in the hash Q buffer **215** and the sub matcher table in a hardware level. If matching by the light pattern matcher **217** is successful, the matched data is stored in the scan Q buffer **219**, and the firewall engine performs an exact pattern matching operation to determine whether the data stored in the scan Q buffer **219** and the whole rule pattern DB are identical to each other in a software level. After that, the firewall engine passes or blocks the packet data according to a result of the exact pattern matching.

Referring to FIG. **19**, if packet data to be filtered is received, the firewall engine performs a packet classifying process with respect to the packet data first, and only if the packet data needs to be pattern-matched as a result of the packet classifying process, the firewall engine matches the packet data and the rule pattern DB. The firewall engine uses the matching unit **119** at least one time when performing the packet classifying process and also uses the matching unit **119** when matching the packet data and the rule pattern DB. A detailed description of this will be provided below with reference to FIGS. **20** to **24**.

The configuration of the firewall engine of FIG. **19** is merely an example and any configuration that can filter the packet data may be applied to the present disclosure.

FIG. **20** is a flowchart illustrating a packet filtering method according to an exemplary embodiment.

Referring to FIG. **20**, if the firewall engine **130** receives packet data to be filtered (operation S**2001**), a header of the packet data is converted into a pattern format (operation S**2003**). A packet classifying process is performed with respect to the packet data using header information of the packet data (operation S**2005**). The pattern format in operation S**2003** may be a format as shown in (a) of FIG. **5**. In this embodiment, operation S**2003** is merely an example and the header of the packet data to be filtered may not be necessarily converted into the format as shown in (a) of FIG. **5**. For example, the exemplary embodiment of FIG. **20** may include operation of extracting header information from the packet data instead of operation S**2003** and perform operation S**2005** using the header information. The packet classifying process will be explained in detail with reference to FIG. **21** below.

If the packet classifying process for the packet data is completed, it is determined whether pattern matching operation S**2007** will be performed or not. In other words, the firewall engine does not perform the pattern matching opera-

tion with respect to all of the packet data, and determines whether to perform the pattern matching operation with respect to the packet data by applying the packet classifying process (operation **S2005**) to the packet data. Only if it is determined that the pattern matching operation will be performed, the pattern matching operation is performed. In the pattern matching operation **S2007**, the packet data is matched with the rule pattern stored in the rule pattern DB. Accordingly, it is checked whether the packet data is matched with the rule pattern or not (operation **S2007**)

For example, the firewall engine checks whether header information of the packet data (IP address, port number, or protocol) is matched with the rule pattern using the matching unit of FIG. **14**, for example. In performing operation **S2007** using the matching unit of FIG. **14**, the hash matcher **211** matches the hash value of the header of the packet data and the hash value of the header of the rule pattern, and if the hash values are matched with each other, the light pattern matcher **217** matches the middle value and the tail value of the header of the packet data and the middle value and the tail value of the header of the rule pattern. If the middle values and the tale values are matched with each other, the firewall engine performs an exact matching operation to match the whole of the header of the packet data and the whole of the header of the rule pattern. If the exact matching is successful, the firewall engine blocks the packet data, as will be explained. If the packet data is matched with the rule pattern, the packet data is allowed or blocked according to the rule pattern (operation **S2009**). On the other hand, if the packet data is not matched the rule pattern, it is determined that the matching is not successful and thus the packet data is passed.

FIG. **21** is a flowchart illustrating a packet classifying process according to an exemplary embodiment.

Referring to FIG. **21**, a packet classifying process includes operations **S2101** to **S2119**, and, if it is determined that packet data is to be pattern-matched as a result of the packet classifying process, the firewall engine performs a pattern matching operation (operation **S2121**). According to an exemplary embodiment, the firewall engine performs the packet classifying process using at least one flag.

The flag may include an IP flag, a protocol flag, a port flag, a flag indicating whether packet data is classified in relation to IP matching, a flag indicating whether packet data is classified in relation to protocol matching, and a flag indicating whether packet data is classified in relation to port matching. In the present exemplary embodiment, the firewall engine may set a value of each flag with reference to the rule pattern DB and/or the sub matcher table shown in (c) of FIG. **5**. The firewall engine may store the flag value in the system register **203** and also may store the flag value in a storage unit (not shown) other than the system register **203**. The firewall engine sets the IP flag to 'All' if there is at least one rule pattern that allows all IP addresses to pass among the rule patterns. In the same way, the firewall engine sets the protocol flag to 'All' if there is at least one rule pattern that allows all protocols to pass among the rule patterns. Also, the firewall engine sets the port flag to 'All' if there is at least one rule pattern that allows all ports to pass among the rule patterns. The above operations of setting the flags may be performed before the packet classifying process is performed or while the packet classifying process is performed.

The flags indicating whether packet data is classified or not are set to 'Yes' or 'No' by the firewall engine during the IP matching operation, the protocol matching operation, and the port matching operation. This will be explained in detail below with reference to FIGS. **22**, **23**, and **24**.

If the firewall engine receives packet data to be filtered, the firewall engine determines whether the IP flag is 'All' or not by checking the IP flag (operation **S2101**). If the IP flag is not 'All', an IP matching process is performed with respect to the packet data (operation **S2103**). The IP matching process will be explained in detail with reference to FIG. **22** below.

After the IP matching process is completed, if the flag indicating whether packet data is classified in relation to IP matching is set to 'N' (operation **S2105**: N), it is determined whether the protocol flag is 'All' or not (operation **S2107**).

The flag indicating whether packet data is classified in relation to IP matching is set to one of 'Y' and 'N' during the IP matching process, as will be explained with reference to FIG. **22**. If the protocol flag is not 'All', the firewall engine performs a protocol matching process (operation **S2109**). The protocol matching operation will be explained in detail with reference to FIG. **24** below.

After the protocol matching process is completed, if the flag indicating whether packet is classified in relation to protocol matching is set to 'N' (operation **S2111**: N), the firewall engine determines whether the port flag is set to 'All' or not (operation **S2113**). If the port flag is set to 'All', it is determined whether the IP flag is set to 'All' (operation **S2119**). If the IP flag is set to 'All', the firewall engine finishes the rule pattern matching operation with respect to the packet data. However, if the IP flag is not 'All' (operation **S2119**: N), a pattern matching operation is performed (operation **S2121**).

If the port flag is not set to 'All' (operation **S2113**: N), the firewall engine performs a port matching process (operation **S2115**). The port matching process will be explained in detail with reference to FIG. **24** below.

After the port matching process is completed, if the flag indicating whether packet data is classified in relation to port matching is set to 'N' (operation **S2117**: N), a pattern matching operation is performed with respect to the packet data (operation **S2121**).

On the other hand, if the flags indicating whether packet data is classified or not are set to 'Y' (operation **S2105**: Y, operation **S2111**: Y, and operation **S2117**: Y), the firewall engine finishes the rule pattern matching operation with respect to the packet data.

FIG. **22** is a flowchart illustrating an IP matching process according to an exemplary embodiment.

The firewall engine performs a hash matching process to determine whether a hash value of an IP address included in a header of packet data is matched with a hash value of an IP address of rule patterns included in the rule pattern DB (operation **S2201**). According to an exemplary embodiment, the hash matcher **211** of the firewall engine matches the hash value of the IP address included in the header of the packet data and the hash matcher table shown in (b) of FIG. **5**. For example, if the hash value of the IP address included in the header of the packet data is 'X', it is determined that the hash values are matched with each other since the hash matcher table displays that 'X' exists.

If matching is not achieved by the hash matching process (operation **S2203**), the firewall engine changes the flag indicating whether packet data is classified or not in relation to IP matching to 'Y' meaning that the packet is classified (operation **S2205**). On the other hand, if matching is achieved by the hash matching process (operation **S2203**), the firewall engine performs a sub matching process to perform a matching operation with respect to the packet using the sub matcher table (operation **S2207**). According to an exemplary embodiment, the light pattern matcher **217** of the firewall engine

matches a middle value and a tail value of the IP address included in the header of the packet data and the sub matcher table shown in (c) of FIG. **5**.

If matching is not achieved by the sub matching process (operation **S2209**), the firewall engine changes the flag indicating whether packet data is classified or not in relation to IP matching to 'Y' meaning that the packet is classified (operation **S2205**). On the other hand, if matching is achieved by the sub matching process (operation **S2209**), the firewall engine identifies an ispro value indicating whether a rule applicable to all protocols exists in the sub matcher table or not, and an isport value indicating whether a rule applicable to all ports exists (operation **S2211**). If the isport value is '1', there is at least one rule pattern applicable to all ports among the rule patterns of the rule pattern DB, and if the ispro value is '1', there is at least one rule pattern applicable to all protocols among the rule patterns of the rule pattern DB.

If the ispro value does not equal to '1' in operation **S2213**, the firewall engine changes the protocol flag to 'Not All' (operation **S2217**). On the other hand, if the ispro value is '1', the firewall engine determines whether the isport value equals to 1 or not (operation **S2215**).

If the isport value does not equal to '1', the firewall engine changes the port flag to 'Not All' (operation **S2219**).

The flags indicating whether packet data is classified or not, the protocol flags, the port flags in the embodiment of FIG. **22** correspond to the flag indicating whether packet data is classified or not used in operation **S2105** of FIG. **21**, the protocol flag used in operation **S2107**, and the port flag used in operation **S2113**, respectively.

FIG. **23** is a flowchart illustrating a protocol matching process according to an exemplary embodiment.

The firewall engine performs a hash matching process to determine whether a hash value of a protocol included in a header of packet data is matched with a hash value of a protocol of rule patterns included in the rule pattern DB (operation **S2301**). According to an exemplary embodiment, the hash matcher **211** of the firewall engine matches the hash value of the protocol included in the header of the packet data and the hash matcher table shown in (b) of FIG. **5**. For example, if the hash value of the protocol included in the header of the packet data is 'Z', it is determined that the hash values are not matched with each other since the hash matcher table displays that 'Z' does not exist.

If matching is achieved by the hash matching process (operation **S2303**), the firewall engine finishes the hash matching process and performs a next operation (for example, operation **S2111** of FIG. **21**). On the other hand, if matching is not achieved by the hash matching process, the firewall engine changes the flag indicating whether packet data is classified or not in relation to protocol matching 'Y' meaning that the packet is classified (operation **S2305**). The flag indicating whether packet data is classified or not corresponds to the flag indicating whether packet data is classified or not used in operation **S2111** of FIG. **21**.

In the present exemplary embodiment, a verification process is performed only by the hash matching process without performing a sub matching process, since the number of cases in which the protocol matching is performed is low. However, this is merely an example and the sub matching process may be performed in the case of the protocol matching.

FIG. **24** is a flowchart illustrating a port matching process according to an exemplary embodiment.

The firewall engine performs a hash matching process to determine whether a hash value of a port included in a header of packet data is matched with a hash value of a port of rule patterns included in the rule pattern DB (operation **S2401**). According to an exemplary embodiment, the hash matcher **211** of the firewall engine matches the hash value of the port included in the header of the packet data and the hash matcher table shown in (b) of FIG. **5**. For example, if the hash value of the protocol included in the header of the packet data is 'A', it is determined that the hash values are matched with each other since the hash matcher table displays that 'A' exists.

If matching is not achieved by the hash matching process (operation **S2403**), the firewall engine changes the flag indicating whether packet data is classified or not in relation to port matching to 'Y' meaning that the packet is classified (operation **S2409**).

If matching is achieved by the hash matching process (operation **S2403**), the firewall engine performs a sub matching process with respect to the packet data (operation **S2405**). According to an exemplary embodiment, the light pattern matcher **217** of the firewall engine matches the hash value of the IP address and the hash value of the protocol included in the header of the packet data and the sub matcher table shown in (c) of FIG. **5**.

If matching is not achieved by the sub matching process (operation **S2407**), the firewall engine change the flag indicating whether packet data is classified or not in relation to port matching is changed to 'Y' meaning that the packet is classified (operation **S2409**). On the other hand, if matching is achieved by the sub matching process, the firewall engine finishes the port matching process and performs operation **S2117** of FIG. **21**.

The flag indicating whether packet data is classified or not used in operation **S2409** of FIG. **24** corresponds to the flag indicating whether packet data is classified or not used in operation **S2117** of FIG. **21**.

FIGS. **25** and **26** explain the effects of using an SOC of an exemplary embodiment.

Referring to FIG. **25**, a difference in the speed of a scanning engine between the scanning engine operating in an application layer and the scanning engine operating in an SOC (50 MHz processor) is illustrated. The amount of time required to scan a certain number of files, i.e., the speed, of the scanning engine operating in the application layer is represented by bars (800 MHz processor) and the amount of time required for the scanning engine operating in the SOC is represented by the lines. The line including the X data points, indicates the time it takes for an Anti-Virus (AV) engine implemented by software and hardware logic (50 MHz SoC processor) performs scanning, and the line including the triangle data points, indicates the time it takes when the scanning is performed by software only.

As the amount of target data to be scanned increases, a SOC AV engine implemented in software and hardware logic shows higher performance than a SOC AV engine implemented in software only. If the number of files to be scanned is about 2000, the SOC AV engine implemented by software and hardware takes almost half as much time when compared to the SOC AV implemented by software only.

In FIG. **26**, the memory utilization and a scanning time in a mobile AV engine which is implemented in software only.

It can be seen that there is similar memory utilization for an AV scanning operation with a low number of files to be scanned, but as the number of files to be scanned increases, it takes much time to scan the files.

Therefore, as the scanning time is longer, battery consumption increases.

FIG. **27** illustrates an amount of power consumed in an AV engine. Products **1** and **2** are AV engines implemented by software only, not SOC-based AV engines. One product consumes about 160 mA and another product consumes about

200 mA. However, the SOC AV engine of the exemplary embodiment consumes about 129.9 mA.

FIG. **28** illustrates a scanning time of an AV engine. Products to be compared are all AV engines implemented by software only versus SOC-based AV engines. Referring to FIG. **28**, the CPU usage of the compared software only products is nearly 100%, while SOC-based AV engine is nearly 30%. Also, the present exemplary embodiment applies a full scanning method, whereas the compared products only apply a fast scanning method (which does not scan all the files, as in the full scanning method), with the exception of one compared product. Therefore, in practice, there may be a greater difference in the scanning time and the CPU usage than shown in FIG. **28**.

FIGS. **29**(*a*), **29**(*b*), and **29**(*c*) are views illustrating a state of a CPU when different AV software is installed in an Android OS phone and is operated. The three different AV software use nearly 100% of the CPU ("Total" "CPU Usage" shown in green) during a scanning operation.

On the other hand, FIGS. **30**(*a*) and **30**(*b*) are views illustrating a state of a CPU when AV scanning is performed using the SOC of the present exemplary embodiment. The CPU usage is equal to or less than 30%. In other words, less CPU capacity is used and operations are performed at a high speed. Therefore, battery consumption is greatly reduced.

If the SOC-based AV is used, a main processor maintains security using less CPU or memory capacity and the CPU has spare space to allow a different application to be used. Therefore, the user can use the different application effectively.

According to one or more exemplary embodiments, the anti-virus H/W and the firewall H/R may be configured by hardware logic so that they can perform simple and swift operations. Also, since the hash matcher, which is a bit table, matches a hash value having a small size and output through a hash function, the hash matcher has an advantage of performing a comparing operation at a high speed. Also, since the light pattern matcher accesses based on the hash value as an index, a result of matching can be swiftly output. Also, if the hash values collide with each other due to a multi-pattern, a sub matcher table regarding collision may be configured to be able to process the hash values in collision.

According to one or more exemplary embodiments, malware may be swiftly filtered and scanned in a mobile device having a limited resource.

According to one or more exemplary embodiments, by using a CPU in a SoC itself in addition to a main CPU of a mobile device, the CPU may operate as an anti-malware system without loading the main CPU. Since the anti-malware system may include various components that are integrated with each other by combining hardware logic and software modules in the form of SoC, the anti-malware system may perform an operation of software, which is to be swiftly changed. In addition, the changed matter of the software may be reflected, and an updating process of a virus DB may be smoothly responded. In particular, requirements for high performance and low power consumption are satisfied in a portable device.

Moreover, filtering may be swiftly processed for a packet by using a FW engine that is configured by hardware logic on a SoC, and a matching result for a file may be swiftly processed for a pattern of a file by using an anti-virus engine that is configured by hardware logic on the SoC.

In addition, since the same pattern may be detected by directly performing operations related to patterning matching on the SoC, an algorithm may always be easily performed if necessary.

While exemplary embodiments have been particularly shown and described above, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. An operating method of an anti-malware system, the operating method comprising: filtering first target data by matching the first target data with rule patterns;

and scanning second target data by matching the second target data with malware patterns, wherein the filtering and the scanning are performed on a system-on-chip (SoC), wherein the filtering of the first target data comprises:

packet classifying the first target data using at least one flag to determine whether the pattern matching is to be performed,

when it is determined that pattern matching is to be performed for the first target data as a result of the packet classifying, carrying out a pattern matching operation between the first target data and the rule patterns;

wherein the filtering the first target data comprises: matching a hash value for a rule pattern, among the rule patterns, with a hash value for at least a portion of the first target data; when the matching the hash value is successful, matching the rule pattern with the first target data;

wherein the matching the hash value comprises matching a hash value for at least one of an Internet Protocol (IP) address, a protocol, and a port, which are included in a header of the first target data, with a hash value for at least one of an IP address, a protocol, and a port, which are included in the rule pattern; and

allowing the first target data to pass by skipping the pattern matching operation between the first target data and the rule patterns, based on a value of the at least one flag that is set without comparing the first target data and the rule patterns.

2. The operating method of claim **1**, wherein:

the first target data is received from a device in which the SoC is installed; and

the filtering is performed on the first target data received from the device.

3. The operating method of claim **1**, wherein:

the first target data is received from an external device through a communication unit included in the SoC; and

the filtering is performed on the first target data received through the communication unit.

4. The operating method of claim **1**, further comprising storing the rule patterns and the malware patterns in a storage unit included in the SoC.

5. The operating method of claim **1**, further comprising:

setting an IP flag to 'All', if a rule pattern that allows all IP addresses to pass is included among the rule patterns;

setting a protocol flag to 'All', if a rule pattern that allows all protocols to pass is included among the rule patterns; and

setting a port flag to 'All', if a rule pattern that allows all ports to pass is included among the rule patterns,

wherein the packet classifying is performed using the IP flag, the protocol flag, and the port flag.

6. The operating method of claim **5**, wherein, if the IP flag is set to 'All' and the port flag is set to 'All', the pattern matching the first target data is not performed.

7. The operating method of claim **1**, wherein:

the packet classifying comprises IP matching to match an IP address included in the first target data with an IP

address included in each of the rule patterns, if there is no rule pattern that allows all IP addresses to pass among the rule patterns; and

if a rule pattern that allows all IP addresses to pass is included among the rule patterns, the IP matching is not performed.

8. The operating method of claim **7**, wherein the pattern matching the first target data is performed only if the IP matching is successful as a result of the IP matching process.

9. The operating method of claim **7**, wherein the IP matching comprises, if the IP matching is successful, checking whether a rule pattern which is successful in the IP matching is applied to all protocols, and if the rule pattern which is successful in the rule matching is applied to all protocols, setting a protocol flag to 'All'.

10. The operating method of claim **9**, wherein:

the packet classifying further comprises, if the protocol flag is not set to 'All', protocol matching to match a protocol included in the first target data with a protocol included in the rule pattern which is successful in the IP matching,

wherein, if the protocol flag is set to 'All', the protocol matching is not performed.

11. The operating method of claim **10**, wherein the pattern matching the first target data is performed only if protocol matching is successful as a result of the protocol matching.

12. The operating method of claim **10**, wherein, if protocol matching is successful as a result of the protocol matching, the packet classifying further comprises checking whether the rule pattern which is successful in the protocol matching is applied to all ports, and, if the rule pattern which is successful in the protocol matching is applied to all ports, setting a port flag to 'All'.

13. The operating method of claim **12**, wherein:

the packet classifying further comprises, if the port flag is not set to 'All', port matching to match a port included in the first target data with a port included in the rule pattern which is successful in the IP matching; and

if the port flag is set to 'All', the port matching is not performed.

14. The operating method of claim **13**, wherein the pattern matching the first target data is performed only if the port matching is successful and if the IP matching is successful.

15. The operating method of claim **1**, wherein the pattern matching between the first target data and the rule patterns comprises:

hash value matching to match a hash value of an IP address included in the first target data with a hash value of an IP address included in each of the rule patterns;

if the hash value matching is successful, light pattern matching to match a middle value and a tail value of an IP address included in a rule pattern which is successful in the hash value matching with a middle value and a tail value of the IP address included in the first target data; and

if the light pattern matching is successful, exact pattern matching to match a rule pattern which is successful in the light pattern matching with the first target data.

16. The operating method of claim **15**, wherein:

the hash value matching comprises matching a hash matcher table with the hash value of the IP address of the first target data; and

the hash matcher table comprises a hash value regarding an IP address included in each of the rule patterns and an item indicating at least one of presence and absence of each hash value.

17. The operating method of claim **15**, wherein:

the light pattern matching comprises matching a sub matcher table with a partial value of the IP address included in the first target data; and

the sub matcher table comprises an item indicating a hash value of an IP address included in each of the rule patterns, and an item indicating a part of the IP address.

18. The operating method of claim **17**, wherein the part of the IP address is a middle value and a tail value of the IP address.

19. The operating method of claim **17**, wherein:

the sub matcher table further comprises an item indicating an address in which the rule patterns are stored; and

the exact pattern matching comprises referring to an address of a rule pattern which is successful in the light pattern matching among addresses in which the rule patterns are stored, and matching the rule pattern stored in the referred address with the first target data.

20. The operating method of claim **17**, wherein:

the sub matcher table further comprises a next item; and

the next item indicates data based on which information on a different rule pattern that has an IP hash value equal to a hash value of an IP address displayed on the item indicating the hash value of the IP address is searched for.

21. The operating method of claim **20**, wherein the data based on which the information on the different rule pattern is searched for is an address in which the information on the different rule pattern is stored.

22. The operating method of claim **1**, wherein the filtering the second target data comprises:

matching a hash value for a malware pattern, among the malware patterns, with a hash value for at least a portion of the second target data; and

when the matching of the hash value is successful, matching the malware pattern with the second target data.

23. The operating method of claim **22**, wherein the matching the hash value comprises matching a hash value for a portion of the second target data with a hash value for the malware pattern.

24. The operating method of claim **22**, wherein the matching the hash value for the malware pattern with the hash value for at least a portion of the second target data comprises:

light pattern matching in which a portion of the malware pattern is matched with a portion of the second target data; and

when the light pattern matching is successful, exact matching in which the malware pattern is matched with the second target data.

25. The operating method of claim **24**, wherein the exact matching comprises matching a third position value and a fourth position value of the second target data with a third position value and a fourth position value of the malware pattern.

26. The operating method of claim **24**, wherein the exact matching comprises matching the second target data with the malware pattern.

27. An anti-malware system for receiving target data, and at least one of scanning and filtering anti-malware, the anti-malware system comprising:

a storage unit which stores a malware pattern;

a first hash value matching unit which matches a hash value of at least a portion of the target data with a hash value of the malware pattern;

a first light pattern matching unit which matches at least one of a middle value and a tail value of the malware pattern with at least one of a middle value and a tail value

of the at least a portion of the target data, when the matching of the hash value is successful; and

an exact pattern matching unit which, when the light pattern matching is successful, refers to an address of a malware pattern which is successful in the light pattern matching among addresses in which malware patterns are stored, and

matches each position of the malware pattern, stored in the referred address, with each corresponding position of the target data;

wherein the filtering the first target data comprises: matching a hash value for a rule pattern, among the rule patterns, with a hash value for at least a portion of the first target data; when the matching the hash value is successful, matching the rule pattern with the first target data;

wherein the matching the hash value comprises matching a hash value for at least one of an Internet Protocol (IP) address, a protocol, and a port, which are included in a header of the first target data, with a hash value for at least one of an IP address, a protocol, and a port, which are included in the rule pattern.

28. The anti-malware system of claim **27**, wherein:

the malware pattern comprises a malware pattern and a rule pattern;

the received target data is to be filtered; and

the first hash value matching unit matches the rule pattern and the target data, and the first light pattern matching unit matches the rule pattern and the target data, when the received target data is classified as data to be filtered by using at least one flag, wherein a value of the at least one flag is set based on the rule pattern prior to at least one of matching by the first hash value matching unit and the first light pattern matching unit.

29. The anti-malware system of claim **28**, wherein, when the received target data is to be malware-scanned, the first hash value matching unit matches the malware pattern and the target data, and the first light pattern matching unit matches the malware pattern and the target data.

30. The anti-malware system of claim **27**, further comprising:

an anti-malware manager which detects the target data as data to be malware-scanned,

wherein the malware comprises a malware pattern and a rule pattern, and

wherein the first hash value matching unit matches the rule pattern and the target data and the first light pattern matching unit matches the rule pattern and the target data according to an order of the anti-malware manager, or the first hash value matching unit matches the malware pattern and the target data and the first light pattern matching unit matches the malware pattern and the target data.

31. The anti-malware system of claim **27**, further comprising:

a second hash value matching unit which matches a hash value of at least a first portion of the target data with a hash value of the malware pattern; and

a second light pattern matching unit which, when the matching of the hash value is successful, matches the malware pattern with a second portion of the target data,

wherein the malware pattern comprises a malware pattern and a rule pattern,

wherein, when the target data is to be filtered, the first hash value matching unit matches the target data to be filtered with the rule pattern and the first light pattern matching unit matches the target data to be filtered with the rule pattern, and

wherein, when the target data is to be malware-scanned, the second hash value matching unit and the second light pattern matching unit matches the target data to be scanned with the malware pattern and the second light pattern matching unit matches the target data to be scanned with the malware pattern.

32. The anti-malware system of claim **31**, further comprising:

an anti-malware manager which receives the target data to be malware-scanned.

33. The anti-malware system of claim **32**, wherein the second hash value matching unit performs an operation on the target data received by the anti-malware manager and the malware pattern and the second light pattern matching unit performs an operation on the target data received by the anti-malware manager and the malware pattern.

34. The anti-malware system of claim **27**, wherein the first hash value matching unit and the first light pattern matching unit are embodied by hardware.

35. The anti-malware system of claim **34**, wherein the hardware comprises:

a buffer which stores the target data;

a hash matcher which matches a hash value for a portion of the target data stored in the buffer with a hash value for the malware pattern;

a hash Queue (Q) buffer which, when the hash value for a portion of the target data stored in the buffer is matched with the hash value for the malware pattern by the hash matcher, stores the target data; and

a light pattern matcher which matches a first position value and a second position value of the target data stored in the hash Q buffer with a first position value and a second position value of the malware pattern.

36. The anti-malware system of claim **35**, wherein:

the hash matcher matches a hash matcher table indicating whether the hash value of the malware pattern exists with the hash value for the portion of the target data; and

when the matching is successful, the target data is stored in the hash Q buffer.

37. The anti-malware system of claim **36**, wherein:

the hardware further comprises a scan Q buffer;

the light pattern matcher matches a sub matcher table comprising at least one record comprising the hash value of the malware pattern, the first position value, and the second position value, with the first position value and the second position value of the target data; and

when the matching is successful, the target data is stored in the scan Q buffer.

38. The anti-malware system of claim **37**, wherein matching the malware pattern with an entirety of the target data is performed on the target data stored in scan Q buffer.

39. The anti-malware system of claim **37**, wherein the hardware further comprises an offset address generator which generates an address for storing a record comprising a hash value of target data stored in the hash Q buffer, from among the at least one record of the sub matcher table.

40. The anti-malware system of claim **39**, wherein the address generated by the offset address generator is related to target data stored in the hash Q buffer, and is stored in the hash Q buffer, together with the target data.

41. The anti-malware system of claim **27**, further comprising a device,

wherein the storage unit and the first hash value matching unit are embodied as a system-on-chip (SoC), and

wherein the SoC is detachably installed in the device, receives the target data from the device, performs the at

least one of the anti-malware scanning and the filtering operation, and notifies the device about a result of the performing.

42. A method of an anti-malware processor, the method comprising:

filtering by a first logic unit of the processor, input data based on a rule; and

scanning by a second logic unit of the processor, for malware in the data, the filtering and the scanning being performed at a same time,

wherein the filtering comprises:

packet classifying the input data using at least one flag to determine whether pattern matching is to be performed;

when it is determined that pattern matching is to be performed for the input data as a result of the packet classifying, performing a pattern matching operation between the input data and rule patterns according to the rule;

wherein the filtering the first target data comprises: matching a hash value for a rule pattern, among the rule patterns, with a hash value for at least a portion of the first target data; when the matching the hash value is successful, matching the rule pattern with the first target data;

wherein the matching the hash value comprises matching a hash value for at least one of an Internet Protocol (IP) address, a protocol, and a port, which are included in a header of the first target data, with a hash value for at least one of an IP address, a protocol, and a port, which are included in the rule pattern; and

allowing the input data to pass by skipping the pattern matching operation between the input data and the rule patterns, based on a value of the at least one flag that is set without comparing the input data and the rule patterns.

43. An anti-malware device comprising: a processor comprising:

a firewall engine which comprises first logic units and which filters input data based on a rule, and determines whether the input data contains data to be scanned for malware; and

an anti-malware engine which comprises second logic units and scans for malware in the input data, if the firewall engine determines that the input data contains the data to be scanned for malware,

wherein:

the firewall engine packet classifies the input data using at least one flag to determine whether the input data is classified as data to be rule pattern-matched,

when it is determined that the input data is classified as the data to be rule pattern-matched, the firewall engine performs a pattern matching operation between the input data and rule patterns, according to the rule;

wherein the filtering the first target data comprises: matching a hash value for a rule pattern, among the rule patterns, with a hash value for at least a portion of the first target data; when the matching the hash value is successful, matching the rule pattern with the first target data;

wherein the matching the hash value comprises matching a hash value for at least one of an Internet Protocol (IP) address, a protocol, and a port, which are included in a header of the first target data, with a hash value for at least one of an IP address, a protocol, and a port, which are included in the rule pattern; and

the firewall engine allows the input data to pass by skipping the pattern matching operation between the input data and the rule patterns, based on a value of the at least one flag that is set without comparing the input data and the rule patterns.

44. A hardware firewall engine comprising at least one processor, the at least one processor configured to perform a filtering operation with respect to packet data based on a packet rule, and determine whether the packet data contains data to be scanned for malware, wherein the filtering operation comprises:

packet classifying the packet data using at least one flag to determine whether pattern matching is to be performed;

when it is determined that pattern matching is to be performed for the packet data as a result of the packet classifying, pattern matching between the packet data and rule patterns according to the packet rule;

wherein the filtering the first target data comprises: matching a hash value for a rule pattern, among the rule patterns, with a hash value for at least a portion of the first target data; when the matching the hash value is successful, matching the rule pattern with the first target data;

wherein the matching the hash value comprises matching a hash value for at least one of an Internet Protocol (IP) address, a protocol, and a port, which are included in a header of the first target data, with a hash value for at least one of an IP address, a protocol, and a port, which are included in the rule pattern; and

allowing the packet data to pass by skipping the pattern matching between the packet data and the rule patterns, based on a value of the at least one flag that is set without comparing the packet data and the rule patterns.

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